THE TRANSITION IN PHYSICS DOCTORAL EMPLOYMENT 1960-1990

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Transition-A Follow-up Study of 1973 Postdoctorals

Beverly Fearn Porter
American Institute of Physics

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SUMMARY OF TRANSITION - A FOLLOW-UP STUDY OF 1973 POSTDOCTORALS

Beverly Fearn Porter
American Institute of Physics

The postdoctoral position is a familiar and traditional one in the field of physics. In the past decade from one-quarter to over forty percent of each new crop of physics PhD's have held temporary postdoctoral positions[1]. These positions have provided the new PhD with an opportunity to further his research experience, to delve more deeply into complex problems and frequently to work with leading research figures in his area. Temporarily freed from teaching and administrative responsibilities, the postdoc's productivity in terms of research publications has been high. For a physicist aiming at a faculty position in the top research oriented universities or a staff position at many Federally Funded Research and Development Centers (FFR&DC's) such as Brookhaven, the postdoctoral position has clearly been a traditional, frequently necessary, stage in the development of his career.

By the 1970's, the job market had changed. Academic tenure track openings became scarce, extremely so at many top research universities, and employment at FFR&DC's had declined. Projections pointed to an increasingly tight academic market through the 1980's and little growth in the FFR&DC's. Thus, the employment spheres where postdoc's usually found later regular employment were very tight and apparently would continue to remain so in the near future.

Yet in 1973 an estimated 2,000 physicists and astronomers[2], including over 40% of the class of 1972, were holding postdoctoral positions. It was suspected that many of these postdocs took these positions because they could not find other suitable employment, and had settled into a temporary holding pattern. The extent to which this was true, and what these postdocs actually experienced during this period has never been fully explored. An understanding of the varying nature of the postdoctoral role is called for.

[1] S. Ellis, "Graduate Student Survey", AIP, annual; "The Invisible University", NAS, 1969. The latter publication presents an extensive description of the nature of the postdoctoral role at that time.

[2] B. F. Porter, "Postdoctoral Positions in Physics and Astronomy", AIP, 1975.

If it was expected that the role of the post doc in the early 1970's had probably changed in unknown ways, the future of these postdocs posed even more challenging questions. How did these physicists caught in the stream of change proceed with their careers, either within or outside of physics? And how have they been affected by their postdoctoral and later employment experiences?

Questions such as those posed above, prompted by general concern in the physics community, led to this follow-up study four years later of the cohort of physicists who had held postdoctoral positions in 1973. In the late spring and early fall of 1977, a seven page questionnaire was sent out to over 1,400 of these 1973 postdoctorals. The response rate was 61%[3].

The following report describes the experiences of these postdocs: in their postdoctoral positions, seeking new employment and in their present work. It should be emphasized that this is a report of instability, transition, and change. Four years is a short period in a career[4] and, particularly when it is at the beginning, change is paramount. As later data will document, only a minority of these physicists have found secure positions; some are only beginning to think about their situations. Four years from now we may have a better idea of where they ended up, but now we have a chance to see them in the midst of change: a crucial period and one perhaps most important to understand for the new cohorts of postdocs now entering the scene.

This study of the changing nature of the postdoctoral role and the later careers of those holding postdoctoral positions in the early 1970's reflects more than academic interest in past phenomena. Although the absolute number of PhD's taking postdoctoral positions immediately after their degrees has decreased in the late 1970's, due to the falling PhD production, and even the percentage appears to have declined, physicists continue to hold such positions in relatively large numbers[5]. Where are they heading?

Insights from the experiences of the 1973 cohort should prove of aid to educational and other policy makers who are presently concerned with the future design of postdoctoral programs and their relationship with other parts of the research structure. They should also prove of interest to new physics PhD's and those still in the pipe-line. They are not meant to be prescriptive; no two experiences are exactly alike. However, they may provide the new generation with at least an opportunity of examining the experiences, both positive and negative, of their peers who passed through but four years ago.

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[3] See Appendix I for detailed description of the methodology used and comparisons of the respondents with the original population. Merrill Anderson at AIP and Dan Harrison, previously at AIP, were of major aid in this study. The APS provided major funding.

[4] Although several respondents noted it seemed the longest four years of their lives.

[5] S. Ellis, "Graduate Student Survey" AIP, 1979.

A summary of the major conclusions of this study is presented in the following pages. A further description forms the body of the main report. Methodological information, statistical detail, and selected quotes may be found in the Appendices of the report.

BACKGROUND CHARACTERISTICS

The postdocs involved in this study were primarily male, U.S. citizens who had received their PhD's from top universities in the early 1970's. Their major dissertation subfields were elementary particles, solid state physics, nuclear physics, atomic and molecular physics and astronomy. In 1973 they were holding temporary postdoctoral positions primarily at universities and the Federally Funded Research and Development Centers.

THE POSTDOCTORAL POSITION

Following the PhD a large proportion of these postdocs sought other positions, mainly within the academic structure. Few offers of anything beyond temporary employment were received. They chose to take the temporary postdoctoral positions both for the traditional reasons of desiring to expand their research experience and the more economically based one of having some physics related employment until they could secure more permanent positions (i.e., the "holding pattern"). A smaller number used the postdoctoral position to move into another research area, occasionally out of physics altogether.

Nearly three-quarters of them took their postdocs in academic institutions primarily in physics and astronomy departments but also in special interdisciplinary and other science and engineering departments. Most of the remainder held postdoctoral positions in Federally Funded Research and Development Centers and government labs. As expected, nearly all their time, 90% on the average, was spent on research, frequently in the same areas in which they had concentrated during their PhD's, although some movement away from the major physics subfields was observed.

EVALUATION OF THE POSTDOCTORAL POSITION

For most of these physicists, the postdoctoral position had provided research experience and, they felt, enhanced their professional reputation. For those now in academic positions it proved an asset to their obtaining job offers and aided some to compete with colleagues and achieve their career objectives. Those who had taken postdoctoral positions in medical physics and biophysics also found the experience useful in defining their career objectives and changing fields.

Most of the respondents, however, did not consider their postdoctoral positions an asset in obtaining job offers, defining or achieving their career objectives or competing with colleagues. Many felt the postdoctoral position had simply been irrelevant. This was particularly true for those now employed in industry where half considered it irrelevant or a liability on most other dimensions.

In terms of job security, most of the respondents felt the postdoctoral position had clearly proved to be more of a liability than an asset. The feeling of lack of security was a theme which permeated these responses. Postdoctoral positions in the past were stepping stones to secure academic positions; they have not proven to be so for this group. As the comments in Appendix II indicate, many of these respondents as they move into their mid and late thirties are concerned for their future.

CAREERS AFTER THE POSTDOC

For half of these physicists, the postdoctoral position described was the only one they took. One-third, however, had held two postdocs; 13% had held three or more. While a sizeable proportion (23%) stayed with their postdoctoral employers, frequently promoted (particularly in the FFR&DC's) most used a variety of means to find their next employment, with the majority contacting employers directly. Formal mechanisms, such as job placement services, advertisements, etc. were used by only a minority. While tenure line university positions were of major interest to this group, the search patterns were fairly broad with nearly one-half looking for industrial and FFR&DC positions, one-third for university non-tenure line and one-fourth for government positions. Most of the searches were quite directed: one, two, to less than ten inquiries. Only in looking for tenure line and industrial positions was there some evidence of a "scattershot approach."

In 1977 one-quarter of these physicists were still in postdoctoral positions or holding non-tenure track academic positions. Another quarter had found apparently tenure track positions; the remainder were in non-academic employment, primarily the FFR&DC's and industry. The distribution between academic and non-academic employment, then, was about half and half, a major departure from the heavy academic dominance of their postdoctoral positions. While the principal reason for taking their current position was that it offered good research opportunities, for a quarter of them it was the only position available.

Where they worked strongly influenced what they were doing. Those in the FFR&DC's, government labs and the upper Roose-Andersen rated departments were quite heavily involved in research. Those employed in other academic departments and industry included a large proportion who were involved in non-research activities, teaching in the first case, development and administration in the second. In many instances, these other activities were combined with some research, but not always. About one-third of each of these groups were primarily involved in the non-research activities noted.

In terms of subfield, the three major subfields of elementary particles, solid state physics and nuclear physcis, experienced declines between the dissertation and postdoctoral position and even heavier declines between the postdoctoral position and current employment. Astronomy appeared rather stable through all three points of time, while employment in optics and medical physics both approximately doubled during the transition between postdoctoral position and current employment.

It is estimated that between ten and fifteen percent of this postdoctoral group has left physics - four years after their 1973 postdoctoral position.

JOB SATISFACTION

Three quarters or more of the respondents were satisfied on their current jobs with their freedom to publish, the congeniality of work relations, voice in selection of research problems and professional challenge. Less than half were satisfied with the internal politics, lack of job security and deadline pressures which they faced. The lack of job security was particularly bothersome. It was considered by this group to be the second most important element in a position, following right after professional challenge.

Overall the most satisfied group appeared to be those working in the FFR&DC's, the least satisfied those employed in industry. However, job satisfaction was not a simple single dimension. While most groups were satisfied with the range of activities and the professional challenge which their positions offered them and few were satisfied with the internal politics they faced, on many other dimensions there were striking variations between physicists working for the different types of employers.

In areas related to individual choice (freedom to publish, voice in research problem selection and autonomy and independence) those employed in the colleges and lower-rated universities appeared the most satisfied with their employment; those employed in industry the least. When it came to research facilities, funding and time for research, physicists working in both those spheres appeared equally deprived, with usually less than half of them being satisfied with this aspect of their work. This was in strong contrast to those working in the FFR&D centers, government installations and the upper-rated Roose-Andersen departments.

There were some tradeoffs for the industrial group. They were more satisfied than any other group with their salaries, and nearly two-thirds were also satisfied with the fringe benefits they received and their job security. In contrast, less than half of those employed in academe were satisfied with their salaries or fringe benefits and few had found any job security.

There have, then, been tradeoffs for a number of these physicists. Some are most satisfied with the individual choice possible in their employment setting, others by support for their research activities, and yet others with financial rewards and job security.

Despite these tradeoffs and the fact that no matter where these postdocs were now employed they were likely to encounter professional challenge and be able to use their physics training, it must be noted that those now employed in industry and to some extent those employed in colleges and the lower rated universities are not finding as much satisfaction as their colleagues. Part of these groups' dissatisfaction appears related to their lowered research involvement. After spending several years beyond the PhD concentrating heavily on research, they have had to make abrupt changes. Some found the change easy, and even welcome. Others, however, are still in the midst of transition and finding it difficult. The comments in Appendix II reflect more directly many of their concerns.

LOOKING BACK AND THE FUTURE

Looking back at their graduate training, a high proportion of these physicists (87%) have found that the analytical approach they learned in physics has been helpful to them in their work and a majority felt their graduate courses had prepared them well for their future employment, although a substantial proportion (40%) wished they had developed a better grasp of the applied aspects of physics in graduate school. The latter was particularly true for those now working in industry.

Their reaction to counseling and faculty attitudes was less positive. Nearly two-thirds felt that their graduate schools had not provided adequate counseling, half felt their advisors were not well-informed on the physics job market and over 40% felt their advisors had disparaged non-academic employment. These negative feelings were most strongly expressed by those currently employed in industry.

If they had it to do over again most would still go into physics; 30%, however, would have chosen other areas, medicine and engineering predominating. Looking ahead, less than half would recommend physics as a career to others. To a large extent this was based on the very tight job market they saw in the future and the high degree of insecurity they had experienced.

These relatively negative attitudes among many of our brightest young physicists should be a matter of continuing concern to the physics community.

TRANSITION - A FOLLOW-UP STUDY OF 1973 POSTDOCTORALS

Beverly Fearn Porter
American Institute of Physics
New York, NY

For the Introduction to and Summary of
this report see pages 17 to 23 of this Volume

BACKGROUND CHARACTERISTICS

The 808 physicists who responded to this follow-up survey were primarily male (96%), U.S. citizens (94%) who had held postdoctoral positions in 1973 at universities in the U.S. and abroad, at Federally Funded Research and Development Centers (FFR&DC's) and to a lesser extent at in-house government labs, industrial companies and non-profit organizations[1]. The nature of their postdoctoral experiences is discussed in the following section.

Over 80% of them had received their PhD's in the early 1970's; less than 5% were six or more years beyond degrees received in the 1960's[2]. While they received their degrees from a broad scattering of universities, over 50% had received their degrees from 20 universities and 35% from ten. These top ten universities were Harvard (37), Cornell (32), Chicago (30), Cal Tech (29), University of Washington (29), University of California - Berkeley (28), MIT (27), Stanford (27), University of Wisconsin (25), and Yale (21) - all top Roose-Andersen rated departments, as were all of the next ten universities[3]. As Table 1 indicates, their major dissertation subfields were: elementary particles, solid state physics, nuclear physics, atomic and molecular physics and astronomy. As we'll see later, except for

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[1] See Appendix I for a presentation of the methodology used in this study, the description of the population and a discussion of non-respondent bias. Since non-citizens on temporary vias were excluded from this study, the citizenship figure does not represent the original 1973 postdoctoral population, where 18% were foreign citizens.

[2] See Appendix I and II for further detail on the different statistics provided in the body of this report.

Subfield of Dissertation	#	%
Elementary Particles	149	18
Solid State Physics	147	18
Nuclear Physics	146	18
Atomic and Molecular Physics	84	10
Astronomy	84	10
Chemical Physics	53	7
Theoretical Physics(a)	30	4
Low Temperature Physics	30	4
Plasma Physics	24	3
Other	61	8
Total	808	

(a) Theoretical physics is used here to refer to those who chose the subfields of "Statistical Mechanics, Relativity and Gravitation and Mathematical Physics" - not just a general theoretical orientation.

Table 1

Subfield of Dissertation for 1973 Postdocs astronomy there has been a heavy departure from each of these major physics subfields in terms of current employment.

THE POSTDOCTORAL POSITION

Why did these physicists take these temporary postdoctoral positions; was it a holding pattern, or was it the traditional desire to expand one's research experience? As Table 2 below indicates, clearly both elements were operating. It should be noted however that 70% of these 808 physicists had sought other positions mainly within, but occasionally outside of the university structure. Few received anything beyond temporary offers of employment. And except for a very few cases these offers were limited to single options. As one respondent noted: "There were several postdoctoral opportunities at top universities. After many letters only one offer for an assistant professor at a mediocre university. My choice of the best postdoctoral positions seemed obvious then. Now I'm not so sure."

According to Table 2 the most frequently cited reason for taking a postdoctoral positions was to further one's research experience, however, clearly more than one factor affected these physicists' decisions, as their pattern of multiple response to several of the other reasons reflects.

The primary reason was also asked for and nearly 80% were able to pinpoint a principal reason. To further one's research experience again remained the leading reason for more than one-quarter of those answering. However for one-third, direct employment reasons were clearly predominant (see starred items in the table) and this probably also held for a number of those who had indicated that they chose the position because it was the "best" physics employment available. Transition to another research area also played a part, although apparently less central than the traditional and employment holding pattern reasons noted above.

For a variety of reasons, then, over 800 responding PhD physicists and astronomers found themselves in temporary postdoctoral positions in 1973. As Table 3 below shows, most of them held academic appointments, with a substantial additional proportion in the FFR&DC's. Nearly 40% of them were holding positions in 20 institutions, 16 academic, 4 non-academic. One-fifth were holding positions in 10 institutions: University of Washington (22), Cal Tech (19), Argonne (18),

	All Reasons		Primary Reason
Reasons Cited	#	%[a]	%
Further Research Experience	617	76	27
Best Physics Employment Available	379	47	18
Explore New Research Area	287	36	11
*Temporary Employment Till More Suitable Found	257	32	8
*Only Physics Employment Available	253	31	19
Work With a Particular Scientist	214	26	5
*Hoped to get "Foot in the Door"	183	26	5
Work at a Particular Institution	174	22	2
Live in Other Parts of the Country[b]	104	13	1
Other Reasons	76	9	3
Establish Contacts with Colleagues	70	9	-
Total Number Base		(795)	(631)

[a] Percentages are not additive since more than one reason could be checked.

[b] Includes desire to live in other countries.

*direct employment reasons

Table 2

Reasons for Taking the 1973 Postdoctoral Position

Employer	%
Academic[a]	73
FFR&DC's	13
Government	7
Nonprofit Organizations	5
Industry	1
Total	100

N = 808

[a] 15% of the academic postdocs held appointments abroad

Table 3

Host Institutions of 1973 Postdoctorals

Cornell (17), MIT (17), University of Maryland (16), Lawrence Berkeley Lab (16), Columbia (15), Princeton (15), and Brookhaven (14). This was not nearly as concentrated as were the institutions from which they received their degrees[3],but considerably more concentrated than their current employment.

Over three-quarters of the academic postdocs were working in physics and astronomy departments, including 6% in special interdisciplinary departments such as biophysics, or geophysics. Nearly one-quarter were in other science and engineering departments with Chemistry, Engineering and Biology predominating.

The official title of over one-half of the postdocs was research associate, 18% were fellows, 15% "postdocs" and 14% held a broad variety of other titles including lecturer, instructor, research assistant, etc. Whatever the title, however, most of their time was spent on research, 90% on the average with 5% in teaching and 5% on other activities. Only 12% spent less than three-fourth of their time on research, only 6% spent more than 25% of their time teaching.

As Table 4 indicates, their subfields had begun to change.

There was significant departures from each of the three major subfields: elementary particles, solid state and nuclear physics, with additional departures from the smaller areas of low temperature physics and "theoretical physics"[4]. (Departures from the major fields were to further accelerate when it came to current employment). Atomic and molecular physics, chemical physics and plasma physics remained relatively stable, while there was some influx into astronomy, biophysics, medical physics and a variety of other areas. As noted earlier, some physicists were using their postdoctoral positions to explore new areas of research, both within and outside of physics.

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[3] A number of these PhD's have found current employment in the above cited and other FFR&DC's. Any current academic employment, however, has been even more deconcentrated. Only the University of Washington and MIT were among the major PhD producing institutions, postdoc employers and current employers.

[4] Theoretical physics is used here to refer to those who chose the subfields of "Statistical Mechanics, Relativity and Gravitation and Mathematical Physics"--not just a general theoretical orientation.

Subfield	Dissertation	Postdoc
Elementary Particles	149	127
Solid State	147	123
Nuclear Physics	146	117
Astronomy	84	95
Atomic and Molecular	84	80
Chemical Physics	53	53
Low Temperature	30	21
Theoretical Physics	30	21
Plasma Physics	24	27
Biophysics	14	39
Optics	9	13
Geophysics	14	39
Medical Physics	1	19
Other[a]	24	58
Total Known	800	801
No Response	8	7
Total	808	808

[a] Other subfields such as electronics, acoustics, fluid dynamics, etc., had between 1 and 3 individuals receiving doctorates.

Table 4

Subfield of Dissertation and Postdoctoral Position

EVALUATION OF THE POSTDOCTORAL EXPERIENCE

Looking back now what do these physicists feel they gained through their postdoctoral experience and to what extent has that experience proven to be an asset or a liability to them? The question is not a simple one to answer. Most of the respondents clearly felt they had gained something from their postdoctoral positions be it necessary research experience, useful skills or a strengthening of their professional self-confidence. On the other hand, over 40% (346 respondents) felt their postdoctoral experience had clearly proven to be a liability to them in one way or another; some other simply considered it irrelevant. Let us look into these areas further.

Table 5 indicates what these physicists primarily felt they had accomplished in their postdoctoral positions.

Not many of them had clarified their career objectives or defined research problems to pursue but most had gained necessary research experience, strengthened their professional self-confidence, acquired useful skills and advanced new scientific findings.

What was gained depended partly on the subfield of postdoctoral research itself. Astronomers, plasma physicists and biophysicists appeared to gain the most in a variety of areas; but medical physicists gained useful skills and established professional contacts, theoretical physicists advanced scientific findings and defined pursuable research problems and three-quarters or more of those in the larger and more diversified field of elementary particles, nuclear physics and solid state did gain necessary research experience[5].

In what ways then did they see their postdoctoral experience as being an asset or a liability? Table 6 presents the distributions on nine different dimensions.

A majority considered their postdoctoral positions to have been an asset in enhancing their professional reputation and in carrying out their present work. Less than half considered it clearly an asset in any of the other areas outlined! And a number of respondents, although not approaching a majority, considered it a clear liability in attaining job security and achieving career objectives. Perhaps most outstanding, however, are the relatively large percentages who considered

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[5] Full distributions by major subfield are available from the author on request.

Accomplishment	% Noting Accomplishment
Gained necessary research experience	77
Strengthened professional self-confidence	67
Acquired skills useful in employment	65
Advanced new scientific findings	63
Established useful professional contacts	60
Completed research project	57
Defined research problems to pursue	43
Clarified career objectives	34
Other	10

Table 5

Postdoc Accomplishments

Areas Evaluated (ordered by highest to least asset)	Asset[a]	Neither[a]	Liability[a]	Total Known
Enhancing professional reputation	67%	24%	10%	767
Carrying out present work	59%	35%	5%	763
Obtaining academic job offers	49%	43%	9%	768
Defining career objectives	48%	44%	8%	762
Competing with colleagues	48%	42%	10%	752
Achieving career objectives	47%	37%	16%	759
Changing field or subfield	40%	49%	10%	758
Obtaining non-academic offers	40%	48%	12%	760
Attaining job security	23%	50%	27%	756

[a] Asset includes Likert scale scores 1 and 2, liability include Likert scale scores 4 and 5, neither includes Likert scale scores 3 and 6 (not relevant).

Table 6

their postdoctoral experience not an asset nor a liability - but irrelevant. It was apparently an experience which occurred, from which they gained, but which had little effect on their later careers, at least as they currently see them. It may also be suggested that many of these physicists simply don't yet know what the effect might be. As we'll see in the next section, most are still not in clearly defined career positions. Thus it is perhaps understandable that many of them cannot yet state whether their postdoctoral position has been an asset or a liability in their attaining job security or achieving career objectives or even in terms of attaining job offers. This group is still in the midst of flux and part of Table 6 reflects that.

For whom was the postdoctoral experience an asset, a liability, an irrelevancy? Were there differences between groups of postdocs or was the pattern reflected in Table 6 simply a reflection of the difficult employment situation in the early 1970's[6]?

In approaching this problem two factors seemed of central interest: 1) what difference did the nature of the postdoctoral role itself play, i.e., how were these physicists affected by where and in what subfield they took their postdoctoral positions, and 2) how relevant to various types of current employment has the postdoctoral experience proven to be?

Closer examination showed that there were differences at least on certain dimensions of evaluation of the postdoctoral position[7]. The postdoctoral positions appears to have been an asset mainly in terms of enhancing ones professional reputation and in carrying out ones present work. We will start here then in examining any variations.

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[6] Recent reports, see S. Ellis, "Graduate Student Survey", AIP 1979, show an improved job market for new PhD's in the late 1970's. There is more choice. And the non-postdoc, but non-faculty university research role is clearly expanding. What that means for the individual scholar and the field itself is little understood. Later comments from some of these experienced physicists now holding such positions may provide some insight.

[7] See Appendix II for detailed breakdowns by postdoctoral institutions and subfield and by current employer.

Two-thirds of these postdocs felt that their postdoctoral experience has definitely been an asset to their professional reputation; few found it a liability. Where they took their positions made little difference. Top university or lower, academic or non-academic, the one clear advantage of the postdoctoral position appears to have been its effect on one's professional reputation. Variations by subfield were somewhat greater with only somewhat over one-half of those who took their postdoctoral positions in low temperature and chemical physics (both relatively small fields) finding the experience aiding their professional reputations in contrast to three-fourths and more of those taking them in astronomy and plasma physics. Only one-half or less of those now employed in industry and other non-federal non-academic positions (154 respondents) felt their postdoctoral experience had been an asset to their professional reputation in contrast to 72% or more of those in university departments and government labs (328 and 66 respondents respectively). Those employed in FFR&DC's and university affiliated research centers fell somewhere between.

There was some variation then on the perceived effect the postdoctoral position had on ones professional reputation. But at least one-half of each of the groups did perceive it as an asset in this respect[8]. Few in any area found it to have been a liability or not relevant; they appeared simply not to be sure yet what its effect would be.

It should be noted that there was some variation on this dimension and on several of the others by specific institution or department where a postdoctoral was held, although most of the variation related to the "quality" of the postdoctoral experience. At some institutions respondents noted that they had had rich, meaningful research experiences; and even if they couldn't continue in the area, they had been rewarded by the experience itself. At other institutions, respondents noted that they had been treated as "lackeys" and second class citizens - "exploitation of cheap labor, with no recognition." Much of this of course, was due to individual variation; there were, however, some consistent institutional patterns. We do not consider it appropriate, here, to make invidious distinctions between departments, many of which may well have changed their practices since 1973. However, several respondents would make the following (paraphrased) suggestion to potential postdocs:

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[8] With the minor exception of the small (28) group employed in "other non-academic" where it fell to 43%.

> "When you choose a postdoctoral position, examine it as carefully, if not more so, than any regular employment position. Find out exactly what is involved and talk to others who are or have been there before. It may be only a 'holding' position, but what kind of 'holding' makes all the difference."[9]

How did these respondents evaluate their postdoctoral experience in terms of its effect on carrying out their present work? Nearly 60% considered it an asset overall and very few found it to have been a liability. However, a number did consider it to be irrelevant and there was substantial variation both in terms of postdoctoral subfield and current employer. Only one-third of the 36 people who had been in low temperature and theoretical physics and less than one-half of those 77 who had been in atomic and molecular physics considered their postdoctoral positions to have been an asset in comparison to 76% and 88% of those who had been in astronomy (92 people) and biophysics (37 people). The first group of subfields had been ones which experienced heavy out-mobility, the latter did not. For many who had changed subfields then, their postdoctoral experience was simply not relevant to what they were now doing.

In terms of present employment, the picture became even clearer as illustrated in Table 7 below.

As one moved further from the top research universities where most of those physicists had taken their postdoctoral positions, the less relevant the postdoctoral experience became. Only a minority of those working in industry considered it an asset. Again while few (13 of the 127 above) considered it a liability, 30% considered it irrelevant and one-fifth considered it neither an asset nor a liability. Many of those physicists currently employed in industry are simply not doing work that is at all related to their postdoctoral positions and, at least as indicated by the comments, some are frustrated at the "waste of time" which they now feel that experience to have been. As we'll see, those employed in industry feel their postdoctoral positions have stood in their way more than those employed in any other area. These positions seem to have been irrelevant to these physicists'

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[9] See Appendix II for a variety of comments from this postdoctoral group.

Current Employer	% Asset	Total Known
Top Roose-Andersen Departments	74	133
Next Level Roose-Andersen Departments	76	63
Lower Roose-Andersen and 4 Year Colleges	67	126
Other Academic[a]	59	61
FFR&DC's	58	144
Government	53	66
Industry	39	127
Other Non-Academic	39	28

[a] Mainly university affiliated research centers - medical schools and foreign.

Table 7

Evaluation of Postdoc in Terms of Carrying Out Present Work
By Type of Current Employer

present work and for many they have proven a liability in terms of obtaining job security and achieving their career objectives. Clearly for these physicists there has been a mismatch between their past and their present; and some are resentful. As one respondent trained in elementary particles and now working in computer science management stated: "I cannot dispell the feeling that I have been cheated. Five years of postdoc training and five years of postgrad education for my PhD seem to have been wasted ... I am more than a little bitter."

If the postdoctoral position had proven generally, if not for all groups, to have been an asset in enhancing one's professional reputation and in carrying out one's present work, it was clearly not considered an asset in attaining job security. This was the one dimension where the postdoctoral position had, at least so far, proven to be more of a liability than an asset; while a full additional one-half had not yet found it relevant or related one way or the other. Variation existed, but in none of the analyses considered here did more than half of the respondents find that their postdoctoral positions had contributed to job security. The highest percentages were found among those (99) who had received associate professorships (46%). On the other extreme, as noted earlier, were the 125 physicists employed in industry. Less than 7% found their postdoctoral experience an asset in attaining job security, a full 40% had already found it a liability.

For many of the other subgroups[10] the effect on job security is not yet known. And this is true for postdocs four years later in every area - even the small group of associate professors noted above. If there is one dominant theme which affects most of this population - it is this feeling of lack of security. Postdoctoral positions in the past were stepping stones to secure academic positions; clearly they have not proven to be so in the present climate. And for these physicists, this has become a basic concern. Most were in their early to mid 30's in 1977; some were older. As we'll see, some had taken multiple postdoctoral positions; a few were still holding them. Most were still in unstable situations. As the comments in Appendix II indicate, personal factors, concerns about spouses, children, and overall life style begin to loom in importance. The postdoctoral position, at least as it has been defined in the past, is a "life" for but a few. Only 5% of this group of 808 physicists stated that they would now be willing to take another postdoctoral position.

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[10] Detailed distributions available from the author on request.

Finally a brief view of the other dimensions of the postdoctoral role can be given. As indicated in Table 6, the postdoctoral position was perceived as somewhat more of an asset in obtaining academic than non-academic job offers. Clearly this was influenced by one's type of current employer. 70% or more of those who were currently employed in academic departments felt their postdoctoral experiences had been as asset in obtaining academic job offers; on the other hand, about 60% of those working in FFR&DC's and government, and 50% of those working in industry felt their postdoctoral experiences had been an asset in their obtaining non-academic job offers. As might be expected, only one-quarter to one-third of each group felt that their positions had helped them receive employment offers in areas where they were not currently employed, i.e., academic positions for those non-academically employed and vice versa.

In terms of competing with colleagues and achieving one's career objectives, current employer was again the major area on which variation occurred. Those who were currently employed in the second tier Roose-Andersen rated departments ("good departments") were most likely to find that their postdoctoral experiences had been an asset in competing with colleagues (70%) and in achieving their career objectives (61%); those employed in industry were among the least likely with only 39% feeling the postdoctoral experience had been an asset in competing with colleagues and 34% feeling it had aided them in achieving their career objectives.

In terms of defining career objectives and changing subfields, the major variation was according to subfield. Those who had taken postdoctoral positions in biophysics and medical physics clearly found them to have been beneficial in these respects. In terms of defining career objectives, 79% and 78% of those taking positions in biophysics and medical physics found them an asset, while 83% and 84% of the respective groups found them an asset in changing fields or subfields.

For most of these physicists, then the postdoctoral position had provided research experience and, they felt, enhanced their professional reputations. For those now in academic positions, it proved an asset to their obtaining academic job offers and aided some to compete with colleagues and achieve their career objectives. Those who had taken their postdoctoral positions in medical and biophysics also found the experience useful in defining their career objectives and changing fields. However, for most of the other groups examined, and particularly for those in industrial employment, the postdoctoral experience had not been an asset to them in any of these dimensions and in the area of job security had already proved a clear liability.

The function of the postdoctoral position and some definition of career paths leading from it, appear needed if the negative experiences of many of these physicists are not to be repeated by future postdocs.

CAREERS AFTER THE POSTDOCTORAL POSITION

Half of the postdocs described in the previous section had held one postdoctoral position, one-third had held two, and 13% had held three or more[11]. Most of the positions lasted two years with a smaller proportion being either longer or shorter. Very few lasted longer than four years. The multiple positions tended to be somewhat shorter on the average than the single ones as Table 8 below indicates.

What has happened to these physicists since they were postdoctorals? 12% are still holding postdoctoral or research associate positions, mainly academic. An additional 12% are holding non-tenure track academic positions with a variety of titles: instructor, senior research associate, assistant and visiting research professor, lecturer and even research assistant. Nearly one-quarter have found apparently tenure track assistant professorships[12]; 4% have become associate professors. The remainder were in non-academic positions, primarily "members of the scientific staff or senior scientists", but also including engineers, systems analysts, managers, vice-presidents, etc. Clearly only a minority of these physicists are in secure, career-line positions; nearly half have left academe.

How did they get where they are and what do they now think of their present employment?

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[11] These figures may be somewhat distorted since it was sometimes difficult to determine from the work history if a given position was a postdoctoral one or not. See methodological discussion.

[12] Whether as assistant professorship was tenure line was not directly ascertained. This 25% figure, then, should be considered an upper boundary.

Average Length	Single Position % of Positions	Double Position % of Positions	Triple Positions % of Positions
1 year or less	25%	32%	48%
2 years	40%	45%	35%
3 years or more	35%	23%	17%
	100%	100%	100%

Table 8

Average Length of Single and Multiple Postdoctoral Positions

Contacted employers independently	1*
Remained with postdoc employer	2*
Contacts made by colleagues	3*
Queries from employers	4*
Information from colleagues	5
Contacts by former professors	6
Ads professional journals	7
Informal contacts with employer	8
AIP placement services	9
University placement services	10
Other	11
Newspaper Ads	12
Other society placement services	13
Civil Service exams	14 (none successful)

*Only means found successful by 10% or more of the group. See Appendix II for distribution of all means used.

Table 9

Successful Means Used to Obtain Present Position

Means Used to Find Current Employment

One-half of these physicists spent three months or less looking for their current employment[13], one-third spent from three months to a year and over 10% spent a year or more. As Table 9 indicates, the primary means used to locate positions was contacting employers directly. Nearly one-half used that method and about one-third of them felt it was primarily responsible for their obtaining the position. A sizeable proportion (23%) stayed with their postdoctoral employer, a few still in postdoctoral positions, but many promoted to higher positions. Other means used were primarily informal: information from and contacts made by colleagues and former professors predominating. Formal mechanisms, such as job placement services, advertisements, etc. were used by a minority; about 15% found jobs through these means.

There was some variation by type of postdoctoral institution. As Table 10 indicates, postdocs from FFR&DC's, and other non-academic centers were more likely to remain at their postdoctoral institution than academic postdocs. Least likely to remain were those who had held positions outside of the very top research departments.

There was only slight variation in the other means used. Over one-quarter of those who had taken postdoctoral positions at top Roose-Andersen rated departments used contacts with their former professors, less than one-fifth of the other postdocs did. More than 10% of those who had taken postdoctoral positions in lower-rated Roose-Andersen departments depended on newspaper advertisements, less than 4% of those from the top-rated departments did. Except for remaining at the postdoctoral institution, however, the variation was slight. Table 9 well reflects the means used by most to find ensuing employment. Informal means continued to predominate in all spheres.

When looking for their next employment, a variety of areas were considered. As noted earlier, nearly one-quarter remained at their postdoctoral institutions; many of these physicists did not look for alternative employment. Some others received an offer and took it, without considering alternatives. Over three-quarters of these physicists (619), however, did consider alternatives to their present employment. Table 11 indicates the areas in which they made inquiries and received offers.

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[13] Includes those who remained with their postdoctoral employer.

Postdoctoral Institution	% Remained	Total Known
FFR&DC's	37	103
Other Non-Academic	28	109
Top Roose-Andersen Departments	23	257
Other Academic	17	330

Table 10

Remained with Postdoctoral Institution by Type of Institution

Employment Area	% Making Inquiries[a]	% Receiving Offers	Total Seeking Alternate Employment[b]
Tenure Line	63	26	619
Non Tenure Line	36	18	"
Other Academic	13	5	"
FFR&DC	42	17	"
Government	26	9	"
Industry	47	22	"
Non Profit	8	3	"
Other	3	2	"

[a] Percentages are not additive since inquiries could be made in and offers received from more than one area.

[b] 189 physicists (23%) considered only the employment option they took. This includes many of those who remained at their postdoctoral institutions who are not included in this table.

Table 11

Inquiries Made and Offers Received by Employment Area

Clearly most of these physicists were looking for tenure line university positions. As Table 11 and our earlier discussion has indicated, only a small proportion have so far found such positions. In general about 40% of those seeking positions in a given area received offers; from half of those seeking non-tenure line positions to only a little over one-third seeking government positions.

As can be noted from Table 11, the search pattern was fairly broad. While tenure line university positions were the major consideration, nearly half looked for industrial and FFR&DC positions, one-third for university non-tenure line and over one-fourth for government positions. Only with the other academic (mainly four year colleges) and non-profit institutions did the search decline. Most of these physicists, then, had not narrowed their options. Most of the searches were quite directed, one, two, to less than 10 inquiries[14]. Only in looking for tenure line and industrial positions was there some evidnece of a "scattershot" approach; one-third of those seeking tenure line positions sent out 10 or more inquiries, 20% of those seeking industrial positions did so. There is no evidence that they were any more likely than other to receive offers; although, as some of the later comments show, they do appear to be more bitter about the experience.

Current Employment

Most of these physicists, then, had looked around, some quite intensively, before choosing their present employment. Shortly we will see where they have ended up and what they are doing. But first why did they take their present positions? Nearly 80% stated a principal reason[15]. Table 12 indicates the principal reasons for taking the current position for the 631 respondents who were able to make such a determination, and also shows the percentage of individuals who indicated each as contributing, if not principal.

Good research opportunities was a predominant reason for these physicists taking their present position; 30% had cited it as the principal reason and nearly two-thirds had cited it as at least one reason for their taking their present position.

[14] See details in Appendix II

[15] A number of others commented that there were too many factors operating to select a major reason - most were able to cite several.

Rank (by principal reason)	Reasons	Principal Reasons (%)	Cited Reason (%)
1	Good research opportunities	30	66
2	Only position available	23	35
3	Professional challenge	11	57
4	Chance for advancement	8	50
5	Job security	8	39
6	Independence and autonomy	6	36
7	Other	4	8
8	Desirable living environment	4	47
9	Personal reasons	3	14
10	Good salary	3	45
11	Interesting colleagues	1	46
12	Work in non-physics area	-	7
		—	—
Total Known		631	800

Table 12

Reasons for Accepting Present Position

Close on its heels, however, was the fact that nearly one-quarter had taken the position because it was the only position available. Other reasons were not considered as central, although half or more did indicate that professional challenge and change for advancement were among the reasons, if not necessarily the principal reason, for their taking their present employment.

Current Employer, Work Activity and Subfield

Certainly one of the central concerns of this study has been what has happened to these physicists four years after they held their postdoctoral positions. Earlier it was noted that only a relatively small proportion had found clear career line positions -- particularly in academe. This is a group still in transition. Table 13 below indicates where they are now employed.

The distribution between academic and non-academic employment is almost half and half, a major departure from the heavy academic dominance of their postdoctoral positions. An examination of the actual places of employment shows a broad dispersion. While one-half of the postdocs had taken their training at 31 institutions, mainly top Roose-Andersen departments and FFR&DC's, one-half of them were now located at 59 institutions. The concentration in employment which did exist, as might have been expected, was at the limited number of FFR&DC installations. Five out of the top ten employing institutions were FFR&DC's: Argonne, Los Alamos, Brookhaven, Lawrence Berkeley Lab and Lawrence Livermore. Argonne, Brookhaven and LBL had also been major trainers of postdocs; Los Alamos and Lawrence Livermore had not. Two government installations, the Naval Research Lab and the National Bureau of Standards, were also among the top ten employing institutions. The three universities were MIT, the University of Washington (Seattle) and the University of Wisconsin.

As Table 13 illustrated, a number of these postdocs are employed at top-rated university departments and FFR&DC's; however, one-third were employed in colleges, lower rated universities and industry where few had been trained. The possible effects of these changes will be discussed in the following section on job satisfaction.

What are these physicists now doing? Table 14 indicates what these physicists are primarily doing by major types of employers[16]. Research is dominant

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[16] Determination of primary work activity is frequently difficult for an individual to determine, particularly when his work involves multiple activities - thus the appearance of the combined categories as they were expressed in the work history. Despite this, the variation in the profiles are illustrative.

Type of Employer	%	N
Academic Subtotal	51	406
Top Roose-Andersen - 18%		
Moderate Roose-Andersen - 8%		
Lower-R-A and Colleges - 16%		
Other Academic[a] - 8%		
Non-Academic Subtotal	49	396
FFR&DC's - 19%		
Government - 8%		
Industry - 17%		
Non-Profit and Other Non-Academic - 5%		
Total Known	100	802
No Response		6

[a] "Other Academic" includes university affiliated research centers, medical and foreign.

Table 13

1977 Type of Employer for 1973 Postdocs

Work Activity	Type of Employers							
	Upper Roose-Andersen	Moderate Roose-Andersen	Other Academic[a]	FFR&DC	Indus.	Govt.	Total[a] Known	
Research	52%	40%	24%	75%	39%	76%	396	51%
Research & Teaching	37%	51%	41%	2%	1%	-	157	20%
Research & Development	2%	-	-	13%	22%	9%	65	8%
Teaching	5%	6%	33%	-	-	-	62	8%
Development & Other[c]	4%	3%	2%	10%	38%	15%	100	13%
	100%	100%	100%	100%	100%	100%		100%
Total With Known Work Activity	147	63	128	147	135	66		780

[a] Other Academic includes 107 in PhD and Masters producing departments and 21 in Bachelors producing departments.

[b] Total includes smaller groups of physicists working, with known work activities for other employers: 35 at university affiliated research centers and medical schools, 27 at non-profit and other non-academic and 32 abroad. The first two groups were heavily involved in research, the latter in both research and teaching.

[c] Other for industry was primarily development, for government it was primarily management.

Table 14

Type of Major Employer by Work Activity

for those in the FFR&DC's and government. In industry it is considerably less so with the primary work activities fairly evenly split between research, research and development and development and other activities. In the academic sphere there was more emphasis on research at the top Roose-Andersen departments with attention to teaching finding its greatest role in the colleges and lower-rated Roose-Andersen university departments. The relatively secondary role which research plays for those working in industry and the "other" academic area may contribute to some of the areas of dissatisfaction observed in these groups in later discussion. Research is certainly not the major or only goal for all PhD physicists, but for this group of physicists who had spent two, three, and sometimes more years in specialized research training after the PhD, it was likely to have more import than for others who had not followed the postdoc routine.

We have seen where these postdocs are employed and what they are doing. How many are still working the areas they were trained for and how many have made changes, both within and beyond physics? Table 15 represents the current outcome of mobility between dissertation, postdoctoral training and employment. The three major subfields of Elementary Particles, Solid State Physics and Nuclear Physics, all of which had experienced declines between the dissertation and postdoctoral position experienced even heavier ones between the postdoctoral position and current employment. Similar declines are seen among those trained in low temperature and theoretical physics. Chemical physics and atomic and molecular physics, which had retained a fairly steady balance between dissertation and postdoctoral position had now also experienced major drops. Astronomy was the one area which in net terms appeared rather stable through all three points of time.

Biophysics and the much smaller geophysics, which had shown growth in the postdoctoral period, both remained fairly stable. Employment in optics and medical physics both approximately doubled during the transition between postdoctoral position and current employment. Some of these physicists had used the postdoctoral position to effect subfield changes; others made the changes later.

In terms of current employment, 20% of the postdocs with known subfields are now working in subfields other than those listed in Table 15 in contrast to 3% who had received degrees in such areas. Approximately half of these - (10%) - have left physics. This however is an underestimate; many of those who did not

Subfield	Dissertation	Postdoctoral Position	Employment
Elementary Particles	149	127	91
Solid State	147	123	84
Nuclear Physics	146	117	78
Astronomy	84	95	89
Atomic and Molecular	84	80	49
Chemical Physics	53	53	39
Low Temperature	30	21	12
Theoretical Physics	30	19	12
Plasma Physics	24	27	34
Biophysics	14	39	34
Optics	9	13	26
Geophysics	5	10	10
Medical Physics	1	19	36
Other[a]	24	58	146
Total Known	800	801	740
No Response	8	7	68[b]
Total	808	808	808

[a] Other subfields such as electronics, acoustics, fluid dynamics, etc., had between 1 and 3 individuals receiving doctorates, and between 4 and 10 presently employed. In employment terms other is mainly non-physics.

[b] Many of these individuals were holding management or other non-research related positions and did not feel subfield designation appropriate.

Table 15

Subfield of Dissertation, Postdoctoral Position and Employment respond to field or subfield of current employment had entered management or non-science positions where field of research may have appeared inappropriate[17]. An estimate of the exit rate from physics four years after the postdoctoral position, then, is probably closer to 15% than the more clearly defined 10% first quoted[18].

Again, it should be noted that this is a group in transition. More will make changes; some will return to physics. But certainly a considerable amount of change has already occurred in four years.

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[17] As the table indicates, 8% of the total 808 respondents did not respond to field or subfield of current employment. Many were holding management or other non-research related positions.

[18] In all of these discussions, we have not considered mobility into closely related interdisciplinary areas such as biophysics, geophysics and medical physics as "leaving physics." A few of these respondents noted that they felt that they had left physics, some were not sure. Others felt they had simply changed their physics concentration.

JOB SATISFACTION

In the last section a picture was obtained of where these postdocs are employed and what they are doing. How satisfied are they with their current positions? Table 16 indicates satisfaction and dissatisfaction on twenty-four different dimensions of job satisfaction[19]. As the table indicates, 70% or more of the respondents were satisfied with their current positions on eleven of these dimensions, with freedom to publish leading all of the rest. On only three dimensions - deadline pressures, job security and internal politics were less than half of the total group of respondents satisfied. The areas which brought the highest percentage of satisfied respondents were[20]: freedom to publish, congeniality of work relationships, voice in selection of research problems and professional challenge. The areas which found the lowest percentage of satisfied respondents were: internal politics, job security and deadline pressures.

In addition to asking the respondents to rate their positions on these varied dimensions, they were asked to rank the three dimensions they considered most important in a position. The most highly valued dimensions were: professional challenge in physics, job security and time for research[21]. As the previous table indicates, none of these items fell among top dimensions on which these physicists found satisfaction. In fact the correlation between importance and satisfaction was not high[22]. Nevertheless 72% did find the professional challenge in physics which the job offered them satisfying and 64% were satisfied with the time available for research.

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[19] This is a slightly expanded and altered list of job satisfaction items, based on suggestions from earlier studies. Job satisfaction is not a single dimension, as will be illustrated. Only occasionally do we use summary scores and they are to be viewed with caution.

[20] See Appendix I for exact wording of items on the questionnaire.

[21] See Appendix II for full listing of ranking of job satisfaction items.

[22] Rank correlation coefficient = 0.27. See Appendix II.

Dimensions	% Satisfied	% Dissatisfied	Total Known	Not Relevant	No Response
Publishing Freedom	83	7	753	37	18
Congeniality	77	6	778	6	24
Voice - Res. Prob. Sel.	76	11	725	60	23
Prof. Challenge-Other	76	7	632	1290	47
Range of Activity	75	8	765	17	26
Physics Use	74	8	774	15	19
Prof. Competence of Coll.	73	7	773	15	20
Prof. Challenge-Physics	72	10	707	76	25
Research Facilities	72	12	741	48	19
Autonomy and Independence	70	10	776	12	20
Employer Standards	70	10	770	12	26
Participate-Dec. Making	66	15	757	32	19
Time for Research	64	19	751	37	20
Research Funding	60	21	731	56	21
Prof. Contacts in Subfield	59	19	749	35	24
Prof. Recognition	56	18	778	12	18
Salary	55	22	781	8	19
Work Load	55	17	764	22	22
Fringe Benefits	54	19	769	16	23
Rewards on Merit	54	18	764	17	27
Advancement Opp.	52	25	776	11	21
Deadline Pressures	48	19	695	89	24
Job Security	47	31	775	11	22
Internal Politics	37	34	748	38	22

[a] Satisfied includes very satisfied and satisfied (Likert scale scores 1 and 2). Dissatisfied includes very dissatisfied and dissatisfied (Likert scale scores 5 and 4).

Table 16

Dimensions of Job Satisfaction

On the second most important dimension, however, the rankings were very dissimilar. Job security was considered the second most important element in a position, yet it ranked 23rd in job satisfaction with only 47% finding some satisfaction and 31% being clearly dissatisfied. Comparison of Table 16 and Appendix Table 5 show several other major discrepancies: advancement opportunities, time for research and rewards based on merit were ranked considerably higher in importance than satisfaction.

On the other hand, freedom to publish, use of physics training, and range of activities engaged in provided satisfaction but were not considered of central importance in a position by those respondents.

Job Satisfaction by Type of Current Employer

Post-postdoctoral employment in physics has traditionally been academic; the advanced postdoctoral training aiding a relatively select group of young physicists to move into faculty positions in major universities, particularly in forefront areas of basic research. As earlier discussion has indicated, some postdocs have made these traditional moves, many others have not. Type of current employer, then, might be expected to be one of the major variable affecting job satisfaction.

Examining overall job satisfaction by type of employer in Table 17 one finds that distinctions exist, but they are hardly major, ranging from 68% of those in the FFR&DC's finding satisfaction with their jobs to 54% of those employed in industry. In fact, those involved in industrial employment are the only group where less than 60% indicate overall job satisfaction.

Job satisfaction, however, as noted earlier is not a simple single dimension. Thus it should not be surprising to find considerably more variation on certain dimensions of job satisfaction by type of employer than we do overall. On a few dimensions, which we'll discuss first, there appear to be general similarities on job satisfaction across employers; on others there are quite striking variations[23].

On the positive side, approximately 70% or more in each employer group were satisfied with the range of activities and the professional challenge[24] which their positions offered them. In addition, two-thirds or more were satisfied with

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[23] See Appendix II for the detailed table of job satisfaction by type of employer on 24 dimensions.

[24] Professional challenge was actually broken into two dimensions-professional challenge in physics and other professional challenge. It is on the latter dimension that a similarly high level of satisfaction across employers was found. Professional challenge in physics shows greater vairability.

Type of Employer	% Satisfied[b]	Total Known[c]
Federally Funded R&D Centers	68	145
Moderate Roose-Andersen Departments	67	63
Government	66	64
Top Roose-Andersen Departments	65	142
University Affiliated Research Centers[d]	61	58
Colleges and Other Academic	60	127
Industry	54	122

[a] Other non-academic, non-profit, etc., is excluded from this discussion due to its small size, 31 total known, and diverse employers which make it up. However it may be noted, with caution concerning the small group size, that 66% of this group also found satisfaction with their current employment.

[b] % satisfied includes those who have indicated very satisfied or satisfied on the five point Likert scale. The figures here are simple unweighted overall satisfaction scores.

[c] Responses varied on each item entering into the overall score. The N's provided here are mainly to guide the reader on the typical size of the group involved.

[d] Includes university affiliated research centers, medical school and foreign university.

Table 17

Job Satisfaction by Type of Employer[a]

the congeniality of their work relationships and 60% or more with the professional standards of their employers, the use of their physics training and the professional competence of their colleagues, although as the table in Appendix II indicates, there was somewhat more employer variability on these latter four dimensions.

On the negative side, considerably less than half were satisfied with the internal politics they found in their positions; in most employer areas only somewhat over one-third felt satisfied with this aspect of their employment and in government the percentage plunged to a low of 17%. While this was not ranked as one of the aspects of a position which these respondents considered particularly important[25], it clearly must have proved irritating to many.

On most other dimensions there was considerable variation between types of employers with those physicists now in industrial employment and those working in colleges and lower-rated universities differing most frequently from their colleagues employed in other settings. Although on most dimensions these differences were on the negative side, this was not always the case. There were some tradeoffs: dimensions on which these groups were actually considerably more satisfied with their jobs than their colleagues.

Let us look, then, at the main employer areas in further detail, noting those dimensions on which the differences in job satisfaction appear major. Table 18 indicates the four dimensions on which physicists in each employer area found the greatest satisfaction and the four dimensions on which they found the least. References will be made to this table and the more detailed one, covering all dimensions in Appendix II. Much of the discussion will center around industrial employment since the variation between physicists employed in this area and others is the greatest; major differences between the other areas, however, will also be highlighted.

As Table 18 indicates, 90% or more of those in each of the academic areas and more than 80% of those in the FFR&DC's and government are satisfied with their freedom to publish. It does not appear as one of the top four dimensions for those employed in industry; in fact less than half (48%) are satisfied with their freedom to publish (Only the top four are listed in Table 18). Although the differences are not quite as strikingly large, a similar pattern emerges when we examine the dimension "voice in research problem selection." Again less than half

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[25] Degree of internal politics ranked 21st out of 24 dimensions. See Appendix II.

	Type of Employer		
	Top Roose-Andersen University Departments	Moderate Roose-Andersen University Departments	College and Other Universities
Most Satisfactory Dimensions	(92%) Freedom to Publish	(94%) Freedom to Publish	(94%) Freedom to Publish
	(85%) Colleague Competence	(91%) Use of Physics	(92%) Voice in Research
	(81%) Range of Activities	(84%) Professional Challenge	(88%) Autonomy
	(81%) Employer Standards	(81%) Voice in Research	(81%) Use of Physics
Least Satisfactory Dimensions	(42%) Advancement	(47%) Internal Politics	(40%) Research Funding
	(40%) Salary	(41%) Fringe Benefits	(38%) Internal Politics
	(39%) Internal Politics	(38%) Salary	(38%) Job Security
	(26%) Job Security	(34%) Job Security	(34%) Fringe Benefits
Total Known	142	63	127

Table 18

Most and Least Satisfactory Dimensions of Employment
by Type of Current Employer

Table 18 (continued)

	Type of Employer			
	University Affiliated Research Centers	FFR&DC	Industry	Government
Most Satisfactory	(93%) Freedom to Publish	(91%) Research Facilities	(74%) Prof. Challenge	(84%) Freedom to Publish
	(83%) Voice in Research	(86%) Congeniality	(72%) Salary	(83%) Research Facilities
	(82%) Range of Activities	(83%) Colleague Competence	(70%) Range of Activities	(82%) Prof. Challenge
	(73%) Autonomy	(81%) Freedom to Publish	(68%) Congeniality	(79%) Congeniality
Least Satisfactory	(41%) Salary	(57%) Work Load	(40%) Recognition	(51%) Advancement
	(32%) Job Security	(52%) Advancement	(39%) Subfield Contacts	(46%) Deadline Press.
	(31%) Rewards-Merit	(43%) Deadline Press.	(38%) Internal Politics	(38%) Rewards-Merit
	(31%) Internal Politics	(39%) Internal Politics	(34%) Deadline Press.	(17%) Internal Politics
Total Known	58	145	127	64

(47%) of those in industrial employment are satisfied in contrast to between 80 to over 90% of those in most of the academic areas, and between 70 and 80% of those in the FFR&DC's and government. There is also some interesting variation here among the different types of academic employers. Those who are the most satisfied with the voice they have in selecting research problems are those working in the "other" academic areas, i.e., colleges and lower-rated universities (92%). While this group, as we will note later, finds problems in other areas, they do find considerable satisfaction in deciding what research they do. In the moderately-rated Roose-Andersen departments and the university related research centers, the percentage dips somewhat to 81% and 83% respectively and finally, in the top-rated Roose-Andersen departments the percentage drops to 62%; not as low as in industry, certainly, but lower than among any of the other types of employers. The explanation for this is not clear, but it may be related to the rather tenuous and junior positions that many of these individuals hold[26], in settings where many of their colleagues are among the forefront leaders in physics.

Autonomy and independence shows a somewhat similar pattern. Less than half of those employed in industry (44%) are satisfied with the autonomy and independence they are allowed in contrast to about three-fourths or more in the various academic sectors, 70% in government and 62% in the FFR&DC's.

As with voice in research problem selection, the group most satisfied with the autonomy and independence they were allowed were those employed in colleges and lower-rated Roose-Andersen departments (88%).

In each of these areas related to individual choice then, a pattern begins to emerge; those in industrial employment appear the most restricted while those in the colleges and lower-rated universities appear the most free.

While research may be encouraged by a latitude of individual choice, it is to a great extent also dependent on the time, facilities and funding to carry out the research. In these respects those postdocs now working in industry and those in colleges and lower-rated universities appear similarly deprived. Less than half of those working in industry and half or less of those working in the colleges and universities find themselves satisfied with the research facilities available (49%

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[26] See later discussion concerning job security.

and 53% respectively), the time open for research (43% and 47% respectively), or the funds provided for research (42% and 40% respectively).

In strong contrast are those working at the FFR&D centers, government installations and the upper-rated Roose-Andersen departments. Approximaely three-quarters or more are satisfied with their research facilities (rising to a high of 91% of those working at the FFR&D centers), and two-thirds to three-quarters are satisfied with the time and funds available for research.

Professional contacts with others in ones subfield of research also acts to further research. Although the differences are not as striking as those described above, less than half of the postdocs now working in colleges and lower-rated universities (48%) and in industry (39%) are satisfied with their professional contacts. While satisfaction with professional contacts in the other employer areas is not quite as high as the facilities for research discussed earlier, it still remains at a moderately high 60-70%.

Earlier we mentioned tradeoffs and saw some of the personal choice areas where those working in colleges and lower-rated universities were finding satisfaction. In a like manner there were areas where those working in industry found themselves considerably more satisfied than those working in many of the other employer spheres. These were usually benefits shared to some extent with those working in the federally funded research and development centers and government. Nearly three-quarters of the postdocs now working in industry were satisfied with their salary, a higher proportion than in any of the other major employer areas. Nearly two-thirds were also satisfied with the fringe benefits they received and their job security. While these figures did not differ markedly from those in the other non-academic spheres[27], they did differ considerably from those physicists who were academically employed. Less than half of those employed in academe were satisfied with their salaries or fringe benefits and very few had found any job security (ranging from 38% of those in other academic areas down to only 24% of those in the top-rated Roose-Andersen departments). And it should be noted that job security was ranked, by these respondents, as the second most important element in a position, following right after professional challenge.

[27] The physicists most satisfied with their job security were those currently employed by the government (75%).

Some mention has been made in the above discussion concerning employment in other spheres besides industry and the colleges and lower-rated universities. A few additional points may be highlighted. A high proportion of those employed in the government found satisfaction in their jobs on a number of the dimensions outlined (two-thirds or more were satisfied on 18 out of the 24 dimensions). The two areas where they differed most from their colleagues were the previously discussed internal politics and rewards on the basis of merit. Only somewhat more than one-third of those in government employment were satisfied with this latter aspect of their employment in comparison to 60% in regular academic departments. The only groups which evidenced as little satisfaction with merit based rewards were those employed in the university affiliated research centers (31%).

Those in the upper Roose-Andersen departments, as indicated earlier, were working in rather positive research environments, but were considerably less pleased with their job security. Their advancement opportunities also appeared more limited than the other groups.

Those working in the university-related research centers were on most dimensions quite similar to those at the top Roose-Andersen departments except for the lack of rewards on merit as noted above.

Those in the FFR&DC's were the most satisfied of all groups overall, and showed the least amount of variation between dimensions. There were only two dimensions on which less than half of this group was satisfied: the ubiquitous "internal" politics and deadline pressures. The latter was among one of the least pleasant aspects of a job for most working in the different non-academic sectors[28]; and those in academe were not particularly happy with this aspect of their positions either. However, it should be noted that few in any sector considered it a particularly important job element. As mentioned earlier, a higher proportion (91%) of the physicists working in the FFR&DC's indicated satisfaction with research facilities than any other group. On most dimensions, however, their responses could be best described as relatively well-satisfied. In some respects, e.g., satisfaction with professional competence of colleagues and standards of employer, they resembled the upper Roose-Andersen departments, and in others, e.g., satisfaction with salary and job security, they resembled the other non-academic employers. One reaction is that physicists working in the FFR&DC's appear to have found if not the best, nearly the best of both worlds - the academic and the non-academic. Another interpretation is that the environment of the individual FFR&DC's vary - some are very like university departments; others are more like industry and thus the attitudes of those working in these environments are likely to reflect such differences. Unfortunately, the number of individuals employed in each FFR&DC is clearly too small to be analyzed in greater detail[29]. As a close examination of Table 6 in Appendix II indicates, there is additional variation on other dimensions, but little as striking as those noted here.

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[28] Those working in "other" non-academic settings, e.g., non-profit organizations, consulting firms, individual entrepeneurs, etc. have not been included in this analysis due to the small size of the group - but as the Appendix table indicates, nearly two-thirds of them did not find deadline pressures, probably influenced by the number of individual consultants in this group.

Job Satisfaction Summary

We've seen in the above discussion that job satisfaction varies on many dimensions between different employers. But almost always there have been tradeoffs. Some are most satisfied with the individual choice possible in their employment setting, others by the support for their research activities and others with the financial rewards and expected continuity of their work. A number of dimensions including professional challenge and use of physics training were high no matter where one was employed. And apparently there was little way of escaping the internal politics which most employment seems to entail.

Nevertheless, despite these similarities and tradeoffs, it must be noted that the postdocs now employed in industry and to some extent those employed in colleges and lower-rated universities are not finding as much satisfaction with their current positions as others. In many ways this is understandable. These physicists have not only concentrated on research while attaining their PhD's, but continued with research training for two, three, or more years beyond, and now many are in positions where research, particularly basic research, is not predominant. Some have found compensation, others - as the comments in Appendix II indicate - have not. The transition is incomplete; many of those currently employed temporarily in the upper Roose-Andersen departments and the university affiliated research centers will also be moving soon. Other studies in this series[30] indicate that eventually most will find greater satisfaction with their positions, both within and outside of physics. But this group of postdocs has been and is still in the midst of a clearly difficult transition. Some will find their way, with no desire of aid; others will be lost.

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[29] It may be suggested that further analysis separates the FFR&DC group, if not by individual center, then by broad research focus.

LOOKING BACK AND THE FUTURE

The postdocs described in the previous sections have had varied experiences, some of which have been fairly traumatic. Most of them are less than a decade from graduate school. Looking back at their brief careers and their graduate school experiences, how do they now evaluate them?

A majority (55%) would still go into physics, if they had a chance to do it over again. Nearly 30% however would not. 162 individuals among this latter group indicated what career areas they would have chosen, as illustrated in Table 19. The classical professions, led by medicine, predominate. However, a much smaller proportion, less than 20% are now contemplating any career change. And most of those who are considering change, are thinking of changing employers - not fields.

What do they think of their graduate school background? A very high proportion (87%) believe that the analytical approach they learned in physics has been helpful to them in their work. About 60% felt the status of their graduate schools had been an asset to them and over half felt their graduate courses had prepared them well for their future employment. The latter points were somewhat more true for those who went into academic, than for those who went into non-academic employment.

A small proportion, less than one-quarter, felt they should have specialized in another subfield of physics, but over 40% wished they had developed a better

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[30] The pilot study of untenured professors, and the study of physics PhD's in industry.

	#	%
Professions	97	60
Medicine	58	36
Engineering	24	15
Other Professions[a]	15	9
Other Science	51	31
Interdisciplinary[b]	15	9
Computer Science[c]	12	7
Biology	9	5
Other Science	15	9
Other[d]	14	9
Total	162	100%

[a] Law and architecture primarily

[b] Biophysics, medical physics, geophysics, etc.

[c] Mainly earth science and chemistry

[d] Mainly business

Table 19

Other Fields of Career Preference

grasp of the applied aspects of physics in graduate school. As might be expected, the latter was particularly true for those now working in industry (55%). There were few clear patterns on any other training dimensions. On most areas, one-quarter to one-third were not sure.

Their reaction to counseling was more definite. Nearly two-thirds felt that their graduate schools had not provided adequate counseling and that was most true for those now employed in industry (73%). Half felt their advisors were not well informed in the physics job market and over 40% felt that their graduate school advisors had disparaged non-academic employment. The latter was particularly true (57%) for those employed in industry and least true for those employed in government (32%). This may have had an effect on the different patterns of job satisfaction in these two non-academic areas, discussed earlier.

These postdocs are admittedly in the midst of change, but, at least so far, less than half of them have felt their careers have gone in intended directions. Only slightly over one-half of those situated in academic departments feel their careers have gone in intended directions, and less than one-third of those in industry feel this way.

With the background they have had, to what extent would these physicists recommend physics as a career for others? Less than half would recommend it; over one-fourth clearly would not. The others remained equivocal. Interestingly this varied little by employer. Over 80% saw a very tight job market ahead. In such a climate, even if experiences had been positive, recommendations were difficult. The quotations in Appendix II elaborate on this.

Summary

Individuals highly trained in physics can do many things, although most would prefer to do physics. Their analytical approach is recognized as being particularly useful. But there are other things involved in getting, holding and making the most of a potentially meaningful position. Counseling may not appear the proper term (and over 10% of the group would not have welcomed it), but clearly this group needed more than it received. They were prepared for basic research careers. Some of them have found careers, although the research, and particularly basic research, is seldom predominant. Some continue to be involved in basic research although long term careers appear questionable. Some, a precious few perhaps, will find both. Only another follow-up study a few years hence will determine that. Between now and then one hopes that the scientific community will feel urged to open up career positions in basic research and recognize the importance of other work activities: applied research, teaching, development, management etc. The future of individuals, and of the fields of science itself will depend on such endeavors.

APPENDIX I

METHODOLOGY

In the late Spring of 1977 a follow-up study of physicists who held postdoctoral positions in 1973 was carried out. The data base used to identify these postdocs was the 1973 AIP-APS Register of physicists, astronomers and related scientists[1]. In that survey individuals had been asked to indicate whether or not they were then holding postdoctoral positions.

Excluded from the population of this follow-up study were individuals in the U.S. on temporary visas in 1973 who had now returned abroad, and individuals who had been misclassified as postdoctoral physicists in 1973. Current addresses were traced using several sources: the membership lists of AIP member societies, the AIP Directory of Physics and Astronomy staff members and major physics publications. 1973 addresses were used as a final alternative, if no more recent addresses were available. Over 1400 seven-page questionnaires were mailed out with one follow-up wave. Domestic mailings included prepaid return envelopes; those sent abroad included prepaid postal return coupons[2]. 130 postal returns came back with untraceable addresses. Most of these were cases where we had had to depend on 1973 addresses. Valid returns were received from 862 individuals, representing a 61% response rate. 808 questionnaires were input to tape, excluding those improperly classified or received late.

A few basic methodological points should be kept in mind when interpreting the results presented in Section II. The first is definitional. Postdoc and postdoctoral position were meant to include temporary non-faculty academic and non-academic research positions held after, but not necessarily immediately following the receipt of the PhD. Except for major departures from this definition, however, we depended on the individual's own assessment as to whether his position in 1973 had been a postdoctoral one or not. A more rigid definition did not appear appropriate during a period of time when we felt the nature of the postdoctoral position itself was in the midst of change. As discussed more fully in the body of this paper, some of these "temporary" positions merged into more permanent ones; some led to faculty positions, while others actually entailed faculty responsibilities without faculty status. In a similar manner, while all of the respondents were considered physicists, by self-definition in 1973, some are no longer in physics and some were actually in the process of leaving the field by means of the postdoctoral position in 1973.

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[1] That survey had an overall response rate of 70%, with the response from PhD physicists estimated at approximately 85%. See "A First Look at the 1973 Register", B. Porter, S. Barisch and R. Sears, Physics Today, April 1974 for description of the Register Survey.

[2] The Pilot Study, an earlier APS study, had indicated that returns from abroad were heightened by inclusion of these coupons. We particularly wanted to encourage returns from those who had taken postdoctoral positions abroad and remained, and others who after a U.S. postdoctoral position went abroad for employment.

The 61% response rate noted above was a fairly respectable return for a questionnaire of this length and detail, although it was not as high as the 73% response experienced with the earlier pilot study. Two basic questions, however, need to be dealt with: what factors appear to have interfered with obtaining a higher response rate and how representative are the respondents to the population being examined?

One factor which interfered somewhat with a higher response was the difficulty four years later in fully tracking current addresses. Approximately 130 (10%) were not traced[3]. As described earlier, the tracking procedure used in the postdoctoral study, although not as exhaustive as in the pilot study, was fairly extensive. However, this was a young, highly mobile group and some tracking problems could be expected. Although the percentage untraced was not high, it does introduce a degree of uncertainty. If studies such as this one are to be conducted again in the future, it is, we believe, crucial that an ongoing data base be maintained.

A second factor may well have been the lack of cover letter personalization[4]. The cost and time elements involved in such personalization

[3] The activities of the post-office make it somewhat difficult to exactly capture the contact population. Usually one expects nearly off post-office returns to occur on the first mailing wave. However on this study, and some others in the series, a good number came back on the second wave. The contact population, then, may be somewhat smaller than assumed.

[4] Personalization would have involved: salutations by individual name, indication of postdoctoral institution, facsimile signatures and collation of multiple personalized documents. The latter appeared most prohibitive.

were considered prohibitive, then, and we had no clear evidence that such efforts would significantly enhance the response. However, the fact that the contact response rate in the pilot study, where personalization was used, was considerably higher than that of any of the other studies does lend credence to the belief that personalization would have improved the response. It is suggested that any future studies which are so detailed and which draw on sometimes sensitive individual attitudes seriously consider more personalized methods.

The major concern, however, is not simply with how large a non-response, but with whether and how it is likely to distort study results. All studies are limited; however, one should know, to the extent possible, the nature of these limitations so that the direction of generalization can be suggested.

Due to limitations in time and funds, no special follow-up study of the non-respondents to the postdoctoral study was carried out. However, some comparisons can be made with the 1973 AIP-APS Register population of postdocs from which this follow-up population was drawn[5].

Tables 20, 21 and 22 compare the respondents to this follow-up study with the original 1973 postdoctoral population on three characteristics: years from degree in 1973, postdoctoral institution in 1973, and major dissertation subfields. In terms of these three background variables, the response group appears to be quite similar to the population from which it was drawn.

Such similarities, although heartening, do not answer some of the crucial questions which may be raised: does this study underestimate the percentage of postdoctoral physicists who have left physics and/or those physicists who have had negative experiences? In response to the first question I think we should assume that this study probably does underestimate the percentage of physicists who have left physics. Typical tracking methods - society membership (AIP or other), publications, Directories of academic and government employers and even forwarding to past postdoctoral institutions were probably less effective with this group than with those who had remained in physics. In addition they may even, if tracked, have felt less of an incentive to reply, particularly if they had loosened all ties with the field. I would then consider any figures presented on the percentage who have left physics as lower limits.

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[5] Although the response to the 1973 AIP-APS Register was high, and included both society members and non-members, it was unlikely that all postdocs responded; some were probably not even contacted. However, comparisons with the NAS sample survey conducted during the same period indicated that the AIP-APS Register had a full representation of the postdoctoral population. The one group where representation was expected to be weakest, non-citizen PhD's holding brief U.S. postdocs on temporary visas were, as noted earlier, excluded from this follow-up study.

Response to the second question is more equivocal. Certainly many physicists with negative attitudes did respond, as the body of this report and the selected quotations in Appendix II indicate. Was the actual proportion of individuals with negative attitudes higher than evidenced in the study results? It is possible; however, results from the two studies where extensive telephone follow-ups were made - the pilot study of untenured junior faculty and the study of faculty who had moved into non-academic positions showed no evidence of such a pattern. In both telphone follow-ups, some dissatisfied physicists were found, but many more were very satisfied with their positions, but simply too busy to complete the long questionnaires. In fact, in the academic to non-academic study, members of the non-respondent sample were somewhat more satisfied with their situation than the respondents; in the pilot study there was no difference.

A final examination was made of late respondents: about 50 responses received after the cutoff date. These late respondents indicated a somewhat higher proportion of individuals living abroad, but their satisfaction and experiences differed little from the group being analyzed[6].

Despite the above discussions, it is possible that there was response bias on other variables not considered here. The reader, then, should remain cautious in placing too much emphasis on specific figures and small differences.

In terms of the questionnaire document itself, a high proportion, usually between 97 and 99%, completed the background fill-in and attitudinal items. A slightly lower percentage - between 93-95% completed the items on evaluation of their postdoctoral position.

[6] Methodologically it has frequently been assumed, although not proven, that late survey respondents are similar to non-respondents.

As in the earlier pilot study, there was still some difficulty with the circling of principal reasons or means. Although a high proportion, over 95%, responded to these questions by checking applicable items, only about three-fourths were willing to circle the principal relevant item. On one question, regarding postdoc accomplishments, the respondents were asked to check any of a variety of accomplishments, which applied and then to rank the two most important accomplishments. This brought a much higher response - 96% indicating the most important accomplishment. It may, then, prove more efficient in the future to change the check and circle type question to check and rank.

Responses to the work history question were quite well filled out, although as indicated earlier interpretation of the "position" item was not always unambiguous. The one area where there was some problem was "reason for leaving position." A number of individuals did not repeat their postdoctoral position in the job history. Since the information was clearly available from the first part of the questionnaire, it was not difficult for the questionnaire editors to insert this material when it was missing from the job history. They were loath, however, to supply a reason for leaving in these cases, although it may be assumed that most reasons involved the termination of the postdoctoral appointment[7].

Open ended comment sections brought different responses. Between 10 and 25% of the respondents commented on specific items. Approximately one-half commented on one aspect of the questionnaire or another. However, the nature of the comments varied widely. Some involved a brief sentence or two; others went on for over a page. Excerpts from these comments are presented in Appendix II. The excerpts do, we believe, represent the comments made, and provide a fuller picture of these respondent's feelings. They have been extremely useful in providing insight into the meaning of the experiences many of these postdocs have encountered, and they have certainly had an influence on some of this author's perceptions. However, it should be kept in mind, all respondents did not comment. These comments should then be treated illustratively, not statistically.

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[7] Data from other respondents indicated that some of these terminations were brought about by an individual's receiving a better job offer.

	Postdoc Study (%)	Original 1973 Survey (%)
1 year or less	42	41
2 years	24	27
3 years	16	17
4 years	9	7
5 years	5	4
6-7 years	2	2
8+ years	2	2

Table 20

Years from Degree (in 1973)

Employer	Postdoc Study (%)	Original 1973 Survey (%)
Academic*	73	75
Industry	1	1
Government	7	7
FFR&DC	13	11
NPO	5	6

*Over 60% of the Academic were in top Roose-Andersen, 25% in other U.S., 15% foreign.

Table 21

Postdoctoral Institutions

Dissertation Subfield	Postdoc Study (%)	Original 1973 Survey (%)
Elementary Particles	18	20
Solid State Physics	18	19
Nuclear Physics	18	15
Atomic and Molecular Physics[a]	17	16
Astronomy	10	9
Other Subfields	19	21

[a] includes chemical physics

Table 22

Dissertation Subfield

APPENDIX II

PART I

Table 1

Background

Age (in 1977)	#	%
40 and over	43	5.3
35 - 39	288	35.6
Under 35	474	58.7

[*] In addition to the tables presented in this appendix, additional ones on Postdoctoral Accomplishments by Selected Subfield, Evaluation of the Post-Doctoral Position by Subfield and by Current Type of Employer are available from the author on request.

Table 2

Department or Division of Postdoctoral Position

a) Physics*	467
b) Astronomy	77
c) Bio-Medical and Radiological Physics	44
d) Geophysics	4
	P and A Subtotal - 592 (78%)
e) Engineering	24
f) Biology	20
g) Chemistry	75
h) Earthscience	5
i) Material Science	18
j) Other Science	29
	Other S and E Subtotal - 171 (22%)
	Total Known - 763
	No Response - 45
	Total - 808

*Excluding Geophysics, Biophysics, Medical and Radiological Physics

Table 3

Alternative Job Inquiries Made and Offers Received For Current Employment

	Tenure Line		Non Tenure Line		Other Academic	
	Inquiries	Offers	Inquiries	Offers	Inquiries	Offers
0	37%	74%	64%	82%	87%	95%
1	6%	17%	8%	12%	4%	4%
2	5%	5%	5%	4%	1%	1%
3-9	18%	4%	8%	3%	3%	-
10-20	13%	-	9%	-	3%	-
Over 20	20%	-	6%	-	3%	-
Total Known*	619		619		619	

	FFR&DC		Government		Industry	
	Inquiries	Offers	Inquiries	Offers	Inquiries	Offers
0	58%	83%	74%	91%	53%	78%
1	12%	12%	9%	8%	9%	13%
2	8%	4%	5%	1%	5%	5%
3-9	16%	1%	5%	-	12%	4%
10-20	4%	-	4%	-	10%	
Over 20	3%	-	3%	-	10%	- -
Total Known*	619		619		619	

Table 3

(con't)

Non-Profit

	Inquiries	Offers
0	92%	97%
1	3%	3%
2	1%	-
3 - 9	1%	-
10 - 20	1%	-
Over 20	1%	-
Total Known*	619	

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* 189 physicists (23%) considered only the employment they took. This includes those who remained at their postdoctoral institutions. They are not included in this table.

Table 4

Means Used to Find Next Employment, by Postdoctoral Institution

a= Remained with postdoc employer

b= Unsolicited queries or offers from potential employers

c= Contacts by colleagues with employers

d= Contacts by former professors with employers

e= Information from colleagues and former professors on job openings

f= Independently contacted potential employers

g= American Institute of Physics placement services

h= Other professional society placement services

i= Informal contacts with potential employers

j= Advertisements in professional journals or newsletters

k= Newspaper advertisements

l= Civil service exams

m= University placement office or employment agencies

n= Other

Table 4

(con't)

Means Used	Total	Upper Roose	Other Roose	Other Ac.	FFR&DC	Other Non-Ac.
a	23%	23%	15%	18%	37%	28%
b	21%	24%	20%	21%	17%	17%
c	33%	34%	39%	30%	33%	30%
d	21%	27%	18%	19%	18%	16%
e	28%	27%	33%	32%	26%	22%
f	45%	46%	51%	44%	41%	42%
g	14%	11%	19%	16%	13%	14%
h	5%	4%	5%	5%	3%	6%
i	22%	23%	22%	23%	19%	23%
j	19%	19%	20%	22%	15%	18%
k	8%	4%	10%	13%	7%	9%
l	1%	1%	2%	1%	-	3%
m	9%	10%	13%	9%	5%	8%
n	6%	6%	9%	5%	3%	5%
Total:	808	259	110	220	103	109

Table 5

Most Important Aspects of a Position, in Rank Order

Rank[1]	Aspects of a Position	Weighted Score[2]
1	Professional challenge in physics	787
2	Job Security	339
3	Time for research	311
4	Other professional challenge	307
5	Autonomy and independence	305
6	Research facilities	296
7	Advancement opportunities	286
8	Professional competence of colleagues	255
9	Congeniality of work relations	223
10	Voice in research problem selection	217
11	Salary	215
12	Available research funding	168
13	Professional recognition	149
14	Rewards on basis of merit	146
15	Range of activities engaged in	132
16	Use of physics training	91
17	Participation in decision making	90
18	Professional contacts in subfield	64
19	Professional standards of my employer	40
20	Freedom to publish	36
21.5	Work load	15
21.5	Degree of internal politics	15
23	Project deadline pressures	14
24	Fringe benefits	7

[1] The rank correlation between importance and satisfaction on these dimensions was $r' = .24$, where $r' = 1 - \frac{6(\Sigma d_i^2)}{N(N^2-1)}$

[2] The weighted score equals sum (three times number ranking item most important plus two times number ranking it second in importance plus one times number ranking it third in importance). 60 people did not provide a first rank, 64 did not provide a second, 68 did not provide a third.

Table 6

Job Satisfaction by Type of Employer

1= Freedom to publish
2= Congeniality
3= Voice - research selection
4= Professional challenge - other
5= Range of activities
6= Use of physics training
7= Professional competence of colleagues
8= Professional challenge - physics
9= Research facilities
10= Autonomy and independence
11= Employer standards
12= Participation - decision making
13= Time for research
14= Research funding
15= Professional subfield contacts
16= Professional recognition
17= Salary
18= Work load
19= Fringe benefits
20= Rewards on merit
21= Advancement opportunities
22= Deadline pressures
23= Job security
24= Internal politics

Note: All numbers are percentages except for "Average Total Relevant"

Table 6

(Con't)

Job Satisfaction by Type of Employer

	(64%) Total % Satisfied	(65%) Top Roose-And. Depts.	(67%) Moderate Roose	(60%) Other Ac.	(61%) Univ, Res. Ctr. etc.	(68%) FFR&DC	(54%) Industry
1	83	92	94	94	93	81	48
2	77	71	72	82	72	86	68
3	76	62	81	92	83	69	47
4	76	72	81	74	70	79	74
5	75	81	78	69	82	74	70
6	74	79	91	81	70	75	62
7	73	85	71	65	66	83	62
8	72	80	84	72	70	78	50
9	72	79	73	53	73	91	49
10	70	79	78	88	73	62	44
11	70	81	67	60	70	80	60
12	66	70	68	75	63	62	56
13	64	76	68	47	71	74	43
14	60	69	62	40	57	75	42
15	59	70	69	48	60	61	39
16	56	67	66	48	65	58	40
17	55	40	38	41	41	67	72
18	55	58	64	43	57	57	50
19	54	49	41	34	43	71	64
20	54	49	58	58	31	63	60
21	52	42	61	54	48	52	60
22	48	54	54	56	49	43	34
23	47	26	34	38	32	57	63
24	37	39	47	38	31	39	38
age l vant	751	142	63	127	58	145	122

Table 6

(Con't)

	Non-Profit Organ. (66%)	Government (66%)
1	75	84
2	80	79
3	78	78
4	79	82
5	76	73
6	52	69
7	81	69
8	56	67
9	63	83
10	83	70
11	64	71
12	67	67
13	64	68
14	48	72
15	68	67
16	64	53
17	73	69
18	71	56
19	59	70
20	73	38
21	57	51
22	64	46
23	53	75
24	39	17
Average Total Relevant	31	64

AMERICAN PHYSICAL SOCIETY STUDY
OF 1973 POSTDOCTORATE HOLDERS

ALL INDIVIDUAL RESPONSES TO THE FOLLOWING QUESTIONS WILL BE KEPT STRICTLY CONFIDENTIAL. THE INFORMATION IS TO BE USED FOR STATISTICAL ANALYSIS ONLY.

REGARDING YOUR 1973 POSTDOCTORAL POSITION

(If you did not hold a postdoctoral position in 1973, check here ☐ and return this sheet)

1) Institution where held ____________________

Department or Division ____________________

Official title of position (if any) ____________________

Dates: From ____________________ (month) (year) To ____________________ (month) (year)

2) What were your reasons for taking a postdoctoral position? (check ✓ all applicable items and circle ✓ the principal reason)

——a) the only physics employment available at that time

——b) the best physics employment available at that time

——c) to further my research experience and skills

——d) to work with a particular scientist

——e) to explore a new research area

——f) to work at a particular institution even if on a temporary basis

——g) to establish contacts with certain colleagues

——h) to live in another part of the country on a trial basis

——i) took it as temporary employment, until more suitable employment could be found

——j) took it hoping to be promoted to a higher rank—as a "foot in the door"

——k) other, specify ____________________

Comments on any of the above: ____________________

____

____

3) What job options did you consider as alternatives to taking the postdoc position? Indicate below the number of job inquiries made and offers received in each employment area. (If you did not consider any other positions, check here____and skip to question 4)

Type of Employer	Inquiries Made Number	Offers Received Number
University, tenure line	____	____
University, non-tenure line	____	____
Other Academic	____	____
Federally Funded Research & Development Center (Brookhaven, etc.)	____	____
Government	____	____
Industry	____	____
Non-Profit	____	____
Other, specify ____________________ ____________________	____	____

4) What percent of your time in your postdoc position did you spend in the following activities:

_____research
_____teaching
_____other (specify) ____
____

5) Indicate which of the following most closely described your major subfield of postdoctoral research.

_____a) Acoustics
_____b) Astronomy and/or Astrophysics
_____c) Atomic and Molecular Physics
_____d) Biophysics
_____e) Chemical Physics
_____f) Electromagnetism
_____g) Electronics
_____h) Elementary Particles
_____i) Fluid Dynamics
_____j) Geophysics
_____k) Low Temperature Physics
_____l) Mechanics
_____m) Medical Physics
_____n) Nuclear Physics
_____o) Optics
_____p) Plasma Physics
_____q) Polymer Physics
_____r) Solid State Physics
_____s) Statistical Mechanics, Relativity & Gravitation, Mathematical Physics
_____t) Other (specify) ____
____

6) Briefly describe your research project.

____
____
____
____

7) What do you feel you accomplished in your postdoc experience? (Please check all that apply)

_____a) gained necessary research experience
_____b) acquired skills useful in subsequent employment
_____c) completed research project
_____d) advanced new scientific findings
_____e) defined research problems to pursue
_____f) clarified career objectives
_____g) established useful professional contacts
_____h) strengthened professional self-confidence
_____i) other (specify) ____
____

A) Rank from above what you felt were the two most important accomplishments.

(Put item letter here)

_____ most important
_____ next most important

8) To what extent do you now feel your postdoc experience has been an asset or a liability, in terms of the following:

	Asset				Liability	Not Relevant
a) obtaining academic job offers	1	2	3	4	5	6
b) obtaining nonacademic job offers	1	2	3	4	5	6
c) competing with colleagues	1	2	3	4	5	6
d) defining career objectives	1	2	3	4	5	6
e) achieving career objectives	1	2	3	4	5	6
f) changing subfield or field	1	2	3	4	5	6
g) attaining job security	1	2	3	4	5	6
h) enhancing professional reputation	1	2	3	4	5	6
i) carrying out present work	1	2	3	4	5	6

j) other, describe ____

Comments on any of the above ____

9) Would you consider accepting another postdoctoral position if it were offered to you today? (Circle the appropriate response)

Yes No Possibly

OTHER POSITIONS HELD

10) Please give a brief career history starting with your present position and going back to your first job after receiving your PhD. (include any other postdoctoral positions held)

	Name and Location of Employer	Position	Dates Held	Principal Work Activity*	Major Physics Subfield or other area** (SEE ITEM 5)	Reason for Leaving Position
Present Position 1						
2						
3						
4						
5						

* i.e. Teaching, Research, Development, Administration etc.

** A) If you are no longer employed in physics, what were your reasons for field change?

_____ a) Change in interest

_____ b) New field held greater professional challenges

_____ c) No satisfactory physics employment available

_____ d) More opportunities to advance in new field

_____ e) Disillusionment with physics as a field

_____ f) Not achieving the success in physics I had hoped for

_____ g) Needed higher salary

_____ h) Felt new field was more in line with my abilities and preferences

_____ i) Personal reasons (family, health, etc.)

_____ j) Future job prospects for physicists looked poor

_____ k) Other (specify) ____

Comments on any of the above: ____

PRESENT EMPLOYMENT

11) Which of the following means did you use in finding your present position? Check ✓all which were used and then circle (✓)the one you feel was mainly responsible for obtaining the position.

_____ a) Remained with postdoc employer

_____ b) *Unsolicited* queries or offers *from* potential employers

_____ c) Contacts by colleagues with employers

_____ d) Contacts by former professors with employers

_____ e) Information from colleagues and former professors on job openings

_____ f) Independently contacted potential employers

_____ g) American Institute of Physics placement services

_____ h) Other professional society placement services

_____ i) Informal contacts with potential employers

_____ j) Advertisements in professional journals or newsletters

_____ k) Newspaper advertisements

_____ l) Civil service exams

_____ m) University placement office or employment agencies

_____ n) Other (specify) ______________________________

12) How long were you actively seeking this position? (months) ______________________________

13) What job options did you consider as alternatives to taking your present position? Indicate below the number of job inquiries made and offers received in each employment area. (If you did not consider any other positions, check here _____ and skip to question 14)

Type of Employer	Inquiries Made Number	Offers Received Number
University, tenure line	_____	_____
University, non-tenure line	_____	_____
Other Academic	_____	_____
Federally Funded Research & Development Center (Brookhaven, etc.)	_____	_____
Government	_____	_____
Industry	_____	_____
Non-Profit	_____	_____
Other, specify _______________	_____	_____
______________________		

14) What were your reasons for accepting your present position. (*Check* ✓ **all applicable items and** *circle* ☑ **the principal reason)**

______ a) Only position available at the time
______ b) Good research opportunities
______ c) Job security
______ d) Interesting colleagues
______ e) Professional challenge
______ f) Chance for advancement
______ g) Desirable living environment
______ h) Good salary
______ i) Promise of independence and autonomy
______ j) Personal reasons (family, health, etc.)
______ k) To work in an area other than physics
______ l) Other reasons, specify ______________________________

____

15) Please evaluate your current position on the following dimensions:

	Very Satisfactory . . . . Very Unsatisfactory	Not Relevant
a) professional challenge in physics	1 . . . . 2 . . . . 3 . . . . 4 5	6
b) other professional challenge	1 . . . . 2 . . . . 3 . . . . 4 5	6
c) use of physics training	1 . . . . 2 . . . . 3 . . . . 4 5	6
d) professional competence of colleagues	1 . . . . 2 . . . . 3 . . . . 4 5	6
e) professional recognition	1 . . . . 2 . . . . 3 . . . . 4 5	6
f) advancement opportunities	1 . . . . 2 . . . . 3 . . . . 4 5	6
g) professional contacts in my subfield	1 . . . . 2 . . . . 3 . . . . 4 5	6
h) research facilities	1 . . . . 2 . . . . 3 . . . . 4 5	6
i) time for research	1 . . . . 2 . . . . 3 . . . . 4 5	6
j) available research funding	1 . . . . 2 . . . . 3 . . . . 4 5	6
k) voice in research problem selection	1 . . . . 2 . . . . 3 . . . . 4 5	6
l) project deadline pressures	1 . . . . 2 . . . . 3 . . . . 4 5	6
m) work load	1 . . . . 2 . . . . 3 . . . . 4 5	6
n) range of activities engaged in	1 . . . . 2 . . . . 3 . . . . 4 5	6
o) participation in decision-making	1 . . . . 2 . . . . 3 . . . . 4 5	6
p) degree of internal politics	1 . . . . 2 . . . . 3 . . . . 4 5	6
q) rewards on basis of merit	1 . . . . 2 . . . . 3 . . . . 4 5	6
r) salary	1 . . . . 2 . . . . 3 . . . . 4 5	6
s) job security	1 . . . . 2 . . . . 3 . . . . 4 5	6
t) fringe benefits	1 . . . . 2 . . . . 3 . . . . 4 5	6
u) congeniality of work relationships	1 . . . . 2 . . . . 3 . . . . 4 5	6
v) freedom to publish	1 . . . . 2 . . . . 3 . . . . 4 5	6
w) autonomy and independence	1 . . . . 2 . . . . 3 . . . . 4 5	6
x) professional standards of employer	1 . . . . 2 . . . . 3 . . . . 4 5	6

Comments on any of the above: ______________________________

____

16) Please rank the three items from the above which you consider the most important in a position.

______ most important
______ second most important
______ third most important

GENERAL ATTITUDES:

Please evaluate the following statements. (Circle the appropriate number on each line)

17) ATTITUDES TOWARD CAREER

	Agree Strongly				Disagree Strongly	Not Relevant
a) If I had a chance to do it over again I would go go into an area other than physics. (Specify: ______________________)	1	2	3	4	5	6
b) My career has gone pretty much in the direction I intended.	1	2	3	4	5	6
c) I would recommend physics as a career for a bright and interested young person.	1	2	3	4	5	6
d) Sexual and/or racial factors had a negative effect on my career progress.	1	2	3	4	5	6
e) I have plans for a career change. (Indicate what the change will be, if applicable: ______________________)	1	2	3	4	5	6
f) The physics job market will be very tight for the foreseeable future.	1	2	3	4	5	6
g) I would rather do physics on less challenging problems than not do physics at all.	1	2	3	4	5	6
h) Career success depends too much on personality and social-psychological factors, rather than merit.	1	2	3	4	5	6

Comments on any of the above: ____

18) ATTITUDES TOWARD YOUR GRADUATE PHYSICS TRAINING

a) The status of my graduate institution was a particular asset to my career progress.	1	2	3	4	5	6
b) My graduate physics courses prepared me well for my future physics employment.	1	2	3	4	5	6
c) I wish I had developed a better grasp of the applied aspects of physics in graduate school.	1	2	3	4	5	6
d) My graduate program should have placed more emphasis on communication skills.	1	2	3	4	5	6
e) The analytical approach I learned in physics is very helpful in my work.	1	2	3	4	5	6
f) I should have specialized in another area of physics in graduate school.	1	2	3	4	5	6
g) A broad physics training is the best preparation for changing job opportunities.	1	2	3	4	5	6
h) My graduate program should have stressed inter-disciplinary team research more.	1	2	3	4	5	6
i) My graduate faculty had too narrow views of physics.	1	2	3	4	5	6

Comments on any of the above: ____

____

ATTITUDES TOWARD YOUR GRADUATE CAREER COUNSELING

	Agree Strongly				Disagree Strongly	Not Relevant
a) My graduate school did not provide adequate career counseling.	1	2	3	4	5	6
b) My graduate school advisors were not well informed on the job market for physicists.	1	2	3	4	5	6
c) My graduate school advisors tended to disparage nonacademic physics employment.	1	2	3	4	5	6

Comment on any of the above: ____

____

KGROUND INFORMATION

Year of Birth ____________ **21) Sex** ______

Citizenship: U.S. ______
Other (Specify) ____________________________________

Year of PhD ____________

Institution of PhD ____________________________

Indicate which one of the following most closely described your major subfield of Dissertation Research:

______ a) Acoustics
______ b) Astronomy and/or Astrophysics
______ c) Atomic and Molecular Physics
______ d) Biophysics
______ e) Chemical Physics
______ f) Electromagnetism
______ g) Electronics
______ h) Elementary Particles
______ i) Fluid Dynamics
______ j) Geophysics
______ k) Low Temperature Physics
______ l) Mechanics
______ m) Medical Physics
______ n) Nuclear Physics
______ o) Optics
______ p) Plasma Physics
______ q) Polymer Physics
______ r) Solid State Physics
______ s) Statistical Mechanics, Relativity & Gravitation, Mathematical Physics
______ t) Other (specify) ____________

____

NK YOU FOR FILLING OUT THIS QUESTIONNAIRE. WE WOULD WELCOME ANY ADDITIONAL COMMENTS YOU JLD CARE TO MAKE WITH RESPECT TO THE TOPICS COVERED IN THIS QUESTIONNAIRE?

____

____

____

____

____

____

____

APPENDIX II

PART II
SELECTED COMMENTS

In the body of this report we have presented the statistical results of the follow-up study of 1973 postdoctoral holders four years later. Comments on a questionnaire like this can not properly be statistically analyzed.[1] However, a good number, nearly one-half of the respondents, did comment - some briefly, some at length. We can not include or do full justice to their expression here. But some presentation of these comments is called for, if we are to begin to fully grasp the experience of these postdocs - both in their postdoctoral positions and later.

Most comments related to the nature of the postdoctoral role and later career experiences. Some commented on their graduate school background; others made more general comments including comments on the role of AIP and APS. The following selection does not, by any means, include all those individuals who were generous enough to provide their comments. It is, we believe, representative -both negatively and positively - of the comments examined. Occasionally we have presented only part of a respondent's long comment. In these cases the dots (...) indicate skipped portions, usually ones which had frequently been commented on before. Any references to specific individuals or institutions have been deleted.

To categorize such comments is difficult. Frequently the comments were too overlapping to provide separate groupings, however, some order appeared preferable to a random assortment.

The comments then are presented under the following captions:

I. Nature of the Postdoctoral Role - Positive, Negative and Neutral

II. Careers After the Postdoc

  A. Job hunting, the market, etc.
  B. Transition and security
  C. Changing fields or subfields
  D. Current employment
  E. Personal and family factors

---

[1] As indicated in Appendix I, individuals with opinions may not necessarily have commented here. Those who did could not be followed up with those crucial questions, "how, why?" Accomplishing the latter would mean a sample of interviews. The author's opinion is that such interviews would be important both to this group and the future of the field.

III. The Graduate School Experience - Courses, Counseling and Faculty Attitudes.

IV. General Ideas on Career, the Postdoctoral Position and Employment Opportunities.

V. Role of AIP-APS.

Comments on the nature of the postdoctoral role were the most frequent type made; they varied considerably both in point of view and tone. The following are a sample of these comments.

--Some respondents found the postdoctoral position very satisfying in providing advanced training and research experience and reacted quite positively.

> "A first rate postdoc situation is an unparalleled opportunity to advance a research career especially in terms of professional competence and professional contacts."

> "My postdoctoral experiences were very ueful in preparing me for a career as a self-sufficient scientist. Some of the time 'lost' as a postdoc was regained - I was tenured early on the basis of my publication record, half of which was work done on postdocs. The postdoctoral years also introduced me to some very useful mentors."

> "In my case postdoctoral experience was a valuable part of my career progress and excellent preparation for later industrial work."

> "I think grad school and postdoc programs can only be designed for a first approximation matching into careers. That is, with a foresight of five years. Within the study program itself, there is contained a breadth of perspective, a freeing of capacities, that is the real permanent contribution an educational-development program can make to a participant's well-being and future usefulness."

--Other respondents found the postdoctoral experience particularly useful in changing fields or career concentrations.

> "The postdoc was a chance to try something new and different, somewhat off the track ... (It) was a very satisfactory experience. Joining an accelerator group composed of five or six persons engaged in an on-going series of experiments afforded the ideal method of getting rapidly involved in a new field of research ... The collaboration with the excellent physicists at -- and the generous manner in which they shared their knowledge and their time contributed to making this such a positive experience."

> "During the course of finding a permanent academic position, I postdoced for 4 years. In the process I changed fields ... I place a premium on this variety of experience and background. I think it has made me a better physicist."

> "Postdoc experience was absolutely essential since I used that training period to gain experience in a new field."

> "Towards the end of the postdoc position, I was allowed considerable flexibility to explore other career avenues that have led to my present position ... While my postdoc tenure provided what turned out to be a satisfying terminal position in research physics, it also provided a transition period between conventional physics employment and my present career. Again I received much encouragement and support from colleagues and employers in seeking an alternative career."

> "Jobs in physics for new Ph.D.'s were scarce in 1971 and I was beginning to feel my horizons were too narrow - I wanted exposure to more of nature and the world than pure physics could offer. Physical oceanography seemed ideal and this postdoc (with two very well known oceanographers) provided the perfect opportunity to give it a try."

--A number of respondents were more equivocal, indicating both positive and negative aspects of the postdoctoral role, frequently with suggestions as to areas for improvement.

> "My own postodoctoral experience was not the best - as my advisor and I did not interact properly ... (However), I can see that the postdoc is a valuable and strong asset to the career of a physicist-even me, who did not make full use of it."

> "I think postdocs should be regarded as apprenticeships, in which the person is assigned a specific advisor and a specific task, and guided closely. As it stands, they are simply underpaid temporary appointments with no job security."

> "In an ideal world (which may have been approached in the late 50's and early 60's) the postdoctoral position serves as a bridge between graduate training (which frequently bears the strong imprint of the thesis advisor) and a career as a professional and independent physicist. In elementary particle physics such careers were centered almost exclusively in universities and large government laboratories. When such positions became endangered species, the nature of the postdoc experience changed, and it was not uncommon for young physicists to hold two, three, or more postdoc positions while remaining in the 'holding pattern.' Needless to say, this lack of security and the need to look for a new job every other year creates a great deal of stress. Like the projected 90% of my contemporaries, I came to a dead end in elementary particle physics (after five years as a postdoc). Now I am attempting to use the postdoc route to establish a career in plasma physics."

> "Finding the right postdoc position is as important as finding a job - one has to select the postdoc position that will lead to the kind of employment position one wants. Most are holding positions or dead ends to academic careers."

> "I was quite happy with the first postdoc job at FFR&DC, but the job at a university was not as pleasant. The university position was supposedly one-half teaching and one-half research. The teaching I actually did was quite comparable to the full time professors. The physics dept. was top heavy with essentially no assistant professor jobs available. Positions were allocated on the basis of politics, not on the individual qualities of postdoc present."

> "The postdoctoral appointments were good as research opportunities and as learning experiences. Two or three years was too short a time to develop a project; as a result everyone seemed constrained to continue working in the same narrow area as previously. The difficulty in changing or broadening areas of research was compounded by the fact that it was virtually impossible to receive a postdoctoral appointment in a subfield other than the one which you were already in."

> "Within the physics community there is a strong feeling that a postdoctoral position should have a limited 1-3 year tenure. Although I agree that it should be limited ... a four year time is more realistic ... Typical experiments in my field especially, involve many years of effort. Without 3-4 years of involvement, one will have no time to work significantly on more than one aspect of the experiment ... It will be particularly difficult to help in fundamental design choices and see the resulting limitations of your choices in final results."

> "My postdoc experience was great, but it had very little to do with what I am doing now. It was neither an asset or liability in any of the above categories. It had little to do with career direction or future employment."

> "In general, the postdoctoral experience encourages or discourages strongly. I have found few who are neutral about what they have been through. I was reinforced by it and found no revelations one way or the other. It was fun - I would not consider doing it again however."

> "My postdoctoral years were the best. I had enough knowledge and skills to be an independent investigator without having to fight with students, deans, or funding agents. However, after the first or second of such temporary positions, too much time and effort had to be devoted to finding a new position."

> "In general, I think that postdoctoral experience is useful. Unfortunately, many schools (and faculty members) treat postdocs as cheap labor and show little concern about the job market."

> "I did not follow through on the area of my postdoc work, so in a sense it was a waste of time. But it did broaden my experience and did convince me my opportunities and abilities were less limited than I had imagined."

--Still other respondents, however, were quite negative either about their specific postdoctoral experience or about the general function of the role in the current employment scene.

> "In many cases postdocs are treated as lower-class physicists. They are used for 3 years - worked very hard to get as much out of them as possible - and then are 'let go' to find another position. At one time it was the grad students who were the 'slaves' in hi energy physics - now it is the postdoc. But the big difference is that the slavery used to end when one got the Ph.D.; now it continues from one postdoc job to another."

> "... industrial postdoc days were very depressing. First of all, industrial research labs tend to hire postdocs to reduce their work loads and are not concerned with the professional growth of postdocs. Permanent staff

members in industrial labs generally look down on postdocs and treat them accordingly."

"The two-year postdoc is an opportunity without substance. What can you accomplish? What can you learn? Too little to be of value. The director of my institute justifies his postdoc program as 'providing promising young scientists with the best training we can give.' But training for what? Where are the jobs we're being trained to fill? I don't see them; neither do my postdoc peers. We are all disillusioned with the job market; the scales have fallen from our eyes."

"... postdoctoral experience is useless except to enhance a person's ability to perform basic research ... all appropriate money should be used to find permanent or semi-permanent reseach positions. The current 'holding pattern' for postdocs has no 'landing strip' available within 20-30 years. Supporting people in this 'holding pattern' is horribly wasteful of money and is destructive of the personal character of people who continue to hope that a permanent, basic research position will someday become available."

"It is apparent that the postdoctoral fellowship is being used for purposes which were not originally intended. Instead of keeping bright young graduates in a holding pattern for a quick improvement in the job market, its use has degenerated into exploitation which is aided and abetted by funding policies of the federal government."

"My postdoctoral position at a prestigious university was a big ripoff. The university got a competent, energetic Ph.D. physicist at a low pay rate, without any commitment to job security. I feel fortunate to have survived that period as a viable physicist."

"The apparent role of the postdoc position in the academic world has changed radically in only a few years. In addition to becoming the proverbial holding pattern for recent graduates, it has become a plentiful and captive source of cheap labor for doing the research of and advancing the careers of established academic people while offering little or no opportunities for advancement to the participants and making it more difficult for the participant to later find permanent work in a different field where professional prospects may be more promising."

"My postdoc was a waste of time after the first year. I would like to have left, but there were no opportunities. Combined with a long time in graduate school ... I find I am entering the job market at a very late age. This is quite unsatisfactory from a career or financial point of view."

"Postdoctoral positions equal cheap labor. Postdoctoral positions advance only the interest of the employer and they should be abolished. They are a substitute for cheap labor."

LATER CAREERS

Job Hunting

"...there was unfortunately little chance of obtaining a permanent university position (anywhere) to continue in this (atomic and molecular) research field. However, since I was not counting on such a position, my future was not adversely affected by this situation."

"My job opportunities improved substantially after I developed skills in computer applications during my postdoc years. I continue to be interested in physics and so have chosen to apply these skills in physics research. However, I have been employed primarily for my computer skills."

"My postdoc turned into a regular position simply because I was at the right place at the right time (i.e., out of 4 postdocs in radiation damage area at FFR&DC, all got regular jobs here)."

"I had had a position in Europe for 3 years, and I wished to return to the U.S.A. Finding jobs in the U.S., while working in Europe is quite difficult."

"To obtain postdoctoral employment I wrote 3 letters and within a month had a job in a new field because: a. I had some low temperature expertise, b. I suggested an interesting experiment, c. the person had just received some funding for a postdoc ... For my present position I wrote 5 letters, received 3 'interested' replies, spoke at two institutions, and received one job offer with research support. If I had not been hired I would have happily stayed on where I was ... the degrading experience of applying to 136 places and being refused by 136 has not been a part of my own experience."

"My career objective at one time was to teach at a small college. By the time I got out of graduate school, achievement of this objective was next to impossible. I found job hunting very discouraging. I attained each of the three jobs I've had since graduate school as a result of contacts with other students in graduate school. My postdoctoral experience was no direct help in attaining a permanent job."

"... advertisements in professional journals or newsletters and newspaper advertisements near useless."

"... people who have not themselves struggled to find a job and who have managed to obtain a job in their chosen field cannot communicate to others the anguish involved in a job search during difficult times."

"This postdoc position has evolved into a sort of staff scientist position here at --, with no limit on job tenure, as long as sufficient contract funds are available ... in my field (solar physics) non-academic (i.e., not tenure track), non-industrial research jobs are the norm rather than the exception, so there is very little stigma attached to the holder of postdoc positions for several years."

"Having taken a postdoctoral position in Australia placed me at an unusual disadvantage in seeking employment."

"It took several years of applications to obtain this position, which is still a temporary position with less pay, fewer fringe benefits, minimal status, and higher workload than positions held by others in the department (men) several of whom do not have doctorates ... I find it difficut to put into words the extreme feelings of anger, frustration, and injustice I entertain. I am in a double bind. If I express my outrage fully at the way junior physicists (particularly female) have been treated over the past years, I annoy senior people and turn them off."

Transition and Security

"The trauma of the postdoc is not knowing where professional security lies and how soon it might come ... This uncertainty takes a psychological toll over time and, of course, moving every two years is very unproductive if one spends half one's time looking for a job ... In my case, I have found what I call 'job security' a knowledge that I can stay someplace if I want to, only this year - five years after leaving my Ph.D. institution and at the age of 32."

"I have been a research associate (postdoc) since Jan. 1971, involved with applied research and supported by grant funds. There are many advantages to this position such as freedom, autonomy, and the opportunity to do research. Disadvantages include a lack of support for this type of work here, and the uncertainty in research support, including salary inherent in research supported by grants. The university has no commitment to me if I don't maintain grant support. I have been seeking a more permanent position in applied research or engineering development for about one year, so far without success."

"The major problem with a postdoc as a transition to a permanent position is that in my case at least, it only deepened the investment of time in a field already over employed. I would like to see a new type of apprenticeship designed to train people in new fields - sponsored by industry ..."

"My future is presently uncertain as my position will end June 1978. My chances for finding an academic position with adequate opportunities for research are remote, so I will probably end up with non-academic and possibly non-physics employment."

"I have never really had career goals, and only recently have my scientific goals become clear. It therefore seems inevitable that I should have spent the past five years in the postdoctoral holding pattern. I am beginning to suspect that I never shall get very far beyond it."

"I have yet to become established in a 'permanent' position and I expect (perhaps a little pessimistically) that I never will. Year-at-a-time research tends to be rather disconnected and inefficient. However, I'm encouraged that I still am working in my chosen field.".

Changing Fields and Subfields

"I turned down two tenure-track assistant professorships in physics in order to go to medical school. The career opportunities in physics are just not as good as those in medicine."

"I find the science/engineering job market very unstable, and very limited in terms of salary. Most positions available are not challenging enough. For these 3 reasons I am switching to computing in private industry."

"Although I have taken an entirely different career direction (sales) I would not have changed what I did in the past. I like physics and I hope someday to use my background in some way. For now, the new career is providing the opportunities for personal growth, income, freedom and independence that I want more than all else."

"I felt disenchantment with 'bigness' of high energy physics and decided to make a complete switch from the field."

"... although I'm doing biology, I don't feel I've 'left' physics because my work (Biol. Oscillations) is broadly encompassed under non-equilibrium thermodynamics."

"Looking back, the postdoctoral positions I held just delayed my leaving physics. I held false hopes that things in physics would improve ... I plan to remain in chemical engineering and not return to physics even though my first love will always be physics."

"I have never regretted the decision to leave basic academic research. There's plenty of challenge in solving practical problems, and lots of satisfaction in doing a good job on problems which may not be on the frontier of physics.

"Left physics because preferred math. Left academic world due to poor job opportunities in both physics and math."

Current Employment

"I am now a senior physicist employed on a year by year basis with salary pegged at about asst. prof. level, fairly heavy teaching load, poor research facilities at low-ranking university. I am suffering all this in the hope that if I hang on, the position will become permanent. I have doubts."

"Worst feature is too many projects, all treated superficially. Best is that diversity of problems and mixed environment is very stimulating." (Industry)

"Career success in industry depends on the profits. A career can be altered drastically if the profits are not sufficient to support R&D, i.e., one gets laid-off."

"The constant job insecurity now the rule in my field (elementary particles) is destructive both to the personalities of the researchers and the quality of their research. The former point is appreciated and ignored by the employing institutions and the latter point is not appreciated."

"Medical physics appears to offer more opportunity for advancement and eventual job security. It also allows opportunity for interesting research and needs no justification beyond the obvious."

From an industrial employed Ph.D.: "I am not working in pure research, but do not consider myself to have left the field of physics. The 'field of physics' does not belong to the academic world. Physics belongs to physicists, however they deem it timely to apply."

"In the past year I have taught on the college and community college level. My broad electrical engineering background has enabled me to teach in electronics, physics and math. I now realize that my research abilities are limited. I hope to move into digital electronics and consult in the field of microcomputers."

"At my present university, the physics department is weak and small; both the university administration and state's economy present poossible future dangers beyond my control ..."

"I detect presumption that a physicist should place top priority on doing 'challenging' frontiers-of-research type work. This image often expressed elsewhere, too - e.g., Physics Today. I suspect it a myth - I suspect most of us more motivated by more prosaic aspects - satisfaction in doing our job well, enjoyable colleagues, pleasant working conditions, adequate salary. Cannot emphasize too much the folly of 'brainwashing' graduate students into romantic belief that ivory-tower, university-level 'frontier' research (e.g., hi-energy physics) is only worthy goal. There is such a breadth of oportunities, and such a need for talented people in applied fields - and these fields often turn out to be more rewarding. Work for industry should be presented as a perfectly honorable alternative (often with greater freedom and usually with higher salaries than academic equivalent)."

"I am reasonably happy with my present position. At one point early in my training some thought that I would end up as tenured faculty at a first-rate institution. Certainly, many institutions offer advantages over the relative isolation of --, Nevertheless, I am probably more comfortable at -- than I ever would have been at such an institution. Here there is a tremendous degree of freedom, but one's research accomplishments depend on his own initiative in a way that is almost frightening."

Personal and Family Factors

"My present employment was not intended to be a career, as such. I plan to try to save as much money as possible in the next few years to 'retire' to a rural area in the northeastern U.S., and seek employment in an 'everyday' occupation to support myself and my family."

"You neglect the problem of 2 careers in one family when asking about job decisions. My wife and I both have had substantial constraints placed on us. She had to limit the set of medical schools she applied to, and her residency choices, and I had to restrict my job searches to times and places that matched her schedule. This problem is increasingly common."

"The pursuit of a career in theoretical physics retards maturation and autonomy: Thirty-year-old men and women with families totally dependent on the whims of senior physicists for jobs."

"One or two postdoc jobs wouldn't be so bad, but knowing that there are almost no permanent (staff) jobs in sight is very demoralizing. When you have a wife and a couple of kids, and you are in your late thirties, the idea of having postdoc jobs for the next 10 years is disgusting."

"... a series of postdocs is not a career. Can't support a family on 10-12k/year."

"I enjoyed studying physics and working in cosmic ray physics. I would have liked to spend a career doing cosmic ray physics and teaching. However, society and economic conditions just would not allow it. Desiring to support a family and coming from a family of modest means, I just could not survive on temporary position salaries with no benefits such as heallth insurance, pension plan, etc."

LOOKING BACK AT THE GRADUATE EXPERIENCE

"My graduate institution followed a pattern which was designed for the 1960-1965 period when jobs were plentiful. We concentrated on courses and then wrote a thesis. My classmates and I were all in the position of seeking jobs and postdocs with no publications to our credit. While our training was very good, we were not competitive with students from institutions which stressed publication while in graduate school.

"I feel strongly that all institutions must include a prerequisite course or courses that will stimulate the majority of students to think about and plan their careers at an early stage when there is still the time to identify, admit, and modify their objectives with a minimal financial and psychological impact."

"I estimate that only 10-15% of my entering graduate class of 60 students is now employed in areas related to their thesis research. This small percentage does not include the most gifted, creative, etc. but those who in one way or another finally broke down and conformed to the system."

"The disparagement (of non-academic physics employment) was subtle, almost totally unspoken; in fact the concept was never openly considered. My present work utilizes physics greatly but the 'fundamental' frontiers of physics aren't relevant; in my 'darkest moments' I still feel like a 'second class' physicist."

"Graduate faculty is in general completely isolated from the nonacademic field."

"I have always been actively interested in the applications of physics, but the general attitude in the many academic physics institutions with which I have been involved has been to discourage or even penalize one for pursuing such interests."

"It is in the self-interest of a faculty to have as many graduate students as possible. Greater awareness of the job market could only lead responsible professors to discourage graduate study. The faculty didn't want to know."

"I feel that my desire for an academic career was totally unrealistic and I feel that the graduate department did much to encourage my misconceptions of the job market and career opportunities."

"My decision to have a career in physics was made as an undergraduate. At the time I did not realize that the ability to make contacts and influence people (political ability) was as important in the world of science as in other fields. Since I was not very talented in politics I therefore leaned more towards science than I would have if I were not under this illusion."

"Typical attitude encountered was that (particle) physics involves a degree of rigor and sophistication which enables its practitioners to do anything (rather like the study of Greek in 19th century England). Potential employers do not always agree."

OTHER GENERAL COMMENTS

"One can't expect a tailor made career that is perfect in all aspects. Of course, career success depends on other things besides merit. However, a physics training is just a tool and one should try to make the most use of it."

"... more attention should be paid to acquainting the graduate student with 'real life' considerations he will face while holding a job and with the wide variety of possible careers for the physics Ph.D. particularly one who has the guts to push on for an MBA. Physics is a rewarding discipline in many fields as well as being a field of research."

"I feel quite strongly that a broad technical training is useful. I also advise students in the strongest possible terms to avoid thinking too narrowly about their careers; I would hesitate to recommend 'physics' as a career but would instead recommend 'research', without reference to a narrow discipline."

"It is obvious that too many physicists are being produced. They are not needed by our economy. Physics faculties must drastically cut down the number of physics students."

"The employment problem today in physics is not a lack of postdoctoral positions but rather a lack of permanent positions. Unless there is some new growth (e.g., research institutes, etc.) outside of academic confines, most good physics Ph.D.'s will ultimately move out of physics research."

"They (postdocs) put in quite a few years of hard work for low pay, yet have little chance of securing a permanent position in the field of their postdocs. Clearly there needs to be a way of moving people more quickly into more permanent positions."

"Physicists need to learn how to communicate subtle physical points with non-physical scientists."

"At this stage of the job market, physics graduate schools should be making more programs in applied areas available, since these research areas can lead to challenging industrial and government R&D positions where there are better opportunities as compared to universities."

AIP AND APS

"The questionnaire is good. However it is unfortunate that there is a 4 year delay in the follow-up. I question how useful such data is, considering changes in events over that period. I feel strongly that the APS should expend much more effort in these directions. The prospect of so many wasted careers for physics Ph.D.'s is a disgrace, and is partly due, I believe, to the very weak APS effort in this area.

"The AIP, APS etc. should try to create scientific positions by vigorous congressional lobbying and other activism. Otherwise the old survive in their tenure and security and the young wither."

"This survey is being done 10 years too late. The APS ignored and denied the existence of problems in academic and nonacademic employment in physics. The APS job placement activities were minimal and for most people, useless."

"It is my belief that the older generation of physicists have done a severe injustice to the young members of the profession. This is particularly true of the APS which I consider to have misbehaved in near criminal fashion, especially by continuing to insist (in Physics Today) that there was never any problem. I expect American science to pay the price because I doubt very much if physics will attract intelligent students in the coming decades."